Boston Parks and Recreation Department

The Emerald Necklace Environmental Improvements Master Plan

Phase I Muddy River Flood Control, Water Quality and Habitat Enhancement

Environmental Notification Form

JASON M. CORTELL AND ASSOCIATES INC.
PRESSLEY ASSOCIATES, INC.

January, 1999

Boston Parks and Recreation Department

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January 29, 1999

JASON M. CORTELL AND ASSOCIATES INC.
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EMERALD NECKLACE
ENVIRONMENTAL IMPROVEMENTS MASTER PLAN
Environmental Notification Form

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EXECUTIVE OFFICE of ENVIRONMENTAL AFFAIRS

ENVIRONMENTAL NOTIFICATION FORM

in accordance with the Massachusetts Environmental Policy Act

EOEA No.: _____

MEPA Analyst: Laura Rome

Phone: 617-727-5830 ext. 234

Project:	**Emerald Necklace Environmental Improvements Master Plan & Phase I Muddy River Flood Control, Water Quality and Habitat Enhancement**
Street:	
Municipality:	City of Boston/Town of Brookline
Watershed:	Muddy River
Latitude and longitude:	N 42E17' 30" to N 42E21'00" W 71E05'30" to W 71E07'30"
Proponent:	Boston Parks and Recreation Department and Brookline Dept. of Public Works
Street:	c/o BPRD, 1010 Massachusetts Avenue
Municipality/State/Zip Code:	Boston, MA 02118
Estimated commencement date:	September 1999 **Estimated completion date:** September 2015
Approximate cost:	Phase I, $43.2 million; Overall $70 million
Status of project design:	5% complete

Copies of this Environmental Notification Form may be obtained from:

Name:	Jason M. Cortell		
Firm/Agency:	Jason M. Cortell and Associates Inc.	**Phone:**	(781) 890-3737 (x120)
Street:	244 Second Avenue	**Fax:**	(781) 890-3430
Municipality/State/Zip Code:	Waltham, MA 02451-1177	**e-mail:**	cortell@cortell.com

Description of the Project and its alternatives (attach additional pages if necessary):

The City of Boston, in association with the Town of Brookline, have undertaken a collective initiative to rehabilitate the Emerald Necklace parklands and restore the Muddy River system as the initial phase of a long range ***Emerald Necklace Environmental Improvements Master Plan*** (see Attachment 4). The Emerald Necklace Environmental Improvements Master Plan is consistent with the 1990 Emerald Necklace Master Plan prepared for the Department of Environmental Management (DEM) by Walmsley/Pressley and contains the same elements, with the addition of a major dredging component.

In order to accommodate the approximately 52 proposed restoration projects, which include new and rehabilitated bridges, bicycle paths, restoration of historic structures and various landscape improvements for the Emerald Necklace over the next 15 years or so, the proponents are submitting for review and comment, an Environmental Improvements Master Plan which, under 301 CMR 11.09, is likely to be eligible for *Area-wide Review* under the *Special Review Procedures* (see Attachment 4).

The Muddy River flood control, water quality and habitat enhancement project is an ideal candidate for *Area-wide review* under the *Special Review Procedures,* given the large geographical extent of the project, the phasing of a suite of project elements, and the large number of interested municipalities, Federal, state

and local agencies, and public interest groups such as the Fenway Alliance, Friends of the Muddy River, and Restore Olmsted's Waterway (ROW). The provisions contained within the *Special Review procedures* allows for a coordinated approach to the intricate and complicated environmental permitting process by incorporating the concerns of these groups and the general public into the overall MEPA process.

MASTER PLAN EIR

Under the guidance of an appointed Citizen's Advisory Committee (CAC), the proponents propose to develop a *Master Plan EIR* which will document *area-wide* environmental impacts, alternatives analyses, and mitigation planning. It is anticipated that the Special Review Procedures will provide for the phased implementation of various improvement projects over an estimated 15-year timeframe and that the *Master Plan EIR* should preclude the necessity for additional environmental review for components which are deemed consistent with the *Master Plan EIR.*

Invariably, the timing and duration of the Master Plan project elements will ultimately be subject to the availability of funding and environmental constraints. However, gross estimates of a time frame can be provided for illustrative purposes only and may include the following time segments:

Phase I (Years 0-5):	Muddy River Dredging, Flood Control, Water Quality Improvements, Aquatic/Riparian Habitat Enhancement, and Best Management Practices (BMP's)
Phase II (Years 5-10):	Landscape Improvements, Revegetation, Traffic Circulation Improvements, Building/Bridge Restoration
Phase III (Years 10-15):	Traffic Circulation Improvements, Building/Bridge Restoration

The Muddy River dredging and associated flood control activities have been designated as Phase I of this initiative and will be the first project undertaken. In order to ensure that the flood control and water quality projects commence as soon as possible, the Proponents are requesting that the Secretary review the overall Master Plan and the proposed Phase I action in parallel and to issue EIR scopes as appropriate.

PHASE I - MUDDY RIVER FLOOD CONTROL EIR (Phase I EIR)

The primary objectives of Phase I are to increase flood control, improve water quality and enhance aquatic/riparian habitat within the Muddy River through a bank-to-bank sediment dredging project. In addition, improvements to drainage culverts and gatehouses will be undertaken by the Boston Water & Sewer Commission and the Brookline Department of Public Works. The proponents propose to determine during the course of the MEPA process what source controls are to be implemented in Phase I and subsequent phases.

- PHASE I Project Elements

  The main components of Phase I call for dredging to depths that correspond to the pre-industrial stream bed and disposal of the following approximate volumes of soft bottom sediments:

1.	Ward's Pond	19,340	cu.yds.
2.	Willow Pond	9,670	cu.yds.
3.	The Riverway	30,000	cu.yds.
4.	Leverett Pond	21,788	cu.yds.
5.	Back Bay Fens	91,102	cu.yds.
	TOTAL	**171,900**	**cu.yds.**

The proposed dredging will deepen the Muddy River system, upgrade flood control, remove nuisance vegetation, improve fisheries/wildlife habitat and water quality, as well as promote and enhance recreational use of the Emerald Necklace parklands. After dewatering and treatment, dredged sediments will be transported to a DEP-approved lined landfill.

Improvements to the infrastructure will involve repairing gatehouse controls, removing system-wide constrictions, replacing undersized culverts, and eliminating combined sewer overflows (CSO's) .

- PHASE I Alternatives

  The following alternatives to the complete dredging of the Muddy River system have been previously identified in a 1998 ACOE study (Alternatives 1-5) and a 1998 Federal Emergency Management Agency (FEMA) directed study (Alternative 5). The ACOE alternatives focus primarily on improving water quality, while the FEMA dredging alternative centers on improving the river's flow regime and it's ability to handle flood stage conditions.

  1. Flow Augmentation: *Involves the introduction of redirected, aerated flow from an external water source.*
  2. Off-Stream Treatment: *Involves the treatment of water outside the source.*
  3. Aeration (in-stream treatment): *Involves the direct introduction of aerated flow from an internal water source.*
  4. Upstream Source Control: *Involves the use of degritters or media filtration units to treat water before it enters the Muddy River.*
  5. Dredging: *The ACOE identified seven levels of dredging, which range from dredging selected stands of giant reed (Phragmites australis) within the Back Bay Fens to dredging the entire Muddy River system. A study conducted for FEMA, stated that the dredging of a single channel within the Lower Fens should be part of a flood mitigation strategy.*

The project proponents will provide a complete alternatives analysis in the Phase I EIR. The selection of the preferred alternative will be dependent upon the effectiveness of the technology, logistics, access constraints, the availability of funding and environmental impacts.

7/98 This is an important notice. Comment period is limited. For information call 617-727-5830.

Schedules attached to this Environmental Notification Form:

Subject Matter of Schedule	Review Threshold(s) met or exceeded (see 301 CMR 11.03)	Related Permit(s) required from an Agency of the Commonwealth (attach a copy of each completed application)	Impact(s) not meeting or exceeding a Review Threshold or requiring a Permit from an Agency of the Commonwealth
(1) Land	Approx. 1 ac. of upland area will be temporarily disturbed through equipment mobilization and dredged material treatment areas		
(2) Rare Species		see schedule	
(3) Wetlands, Waterways & Tidelands	Approximately 41 acres of land under water, 1.6 acres of bordering vegetated wetlands, and 5.8 acres of bank will be impacted by the dredging. Other resources include bordering land subject to flooding and the buffer zone	Wetlands Protection Act Rivers Protection Act NEPA Request for a Determination of Applicability (RDA) Notice of Intent (NOI) Order of Conditions (OOC) Chapter 91	
(4) Water		Section 401 NPDES permit Section 401	
(5) Wastewater			see schedule
(6) Transportation			see schedule
(7) Energy			see schedule
(8) Air			Temporary elevated CO levels from dredging equipment
(9) Solid & Hazardous Waste		The disposal of 171,900 cu.yds. of bottom sediments will require coordination with the DEP. All material will be disposed of at a DEP-approved landfill, some of which has been classed as hazardous.	
(10) Historical/Archaeological Resources			see schedule
(11) ACECs			

Is this an Expanded ENF requesting:

a Single EIR?	**__ Yes**	**_X No (see 301 CMR 11.06(8))**
a Special Review Procedure?	**_X Yes**	**__ No (see 301 CMR 11.09)**
a Waiver?	**___Yes**	**_X No (see 301 CMR 11.11)**

List of any Financial Assistance or Land Transfer from an Agency of the Commonwealth:

Although several sources of funding have been sought and received, additional funding is needed for this project. Table 1 indicates some of the major projects, associated costs and potential sources of funding.

Table 1. Estimated Costs for the Muddy River Dredging

Cost Element (Approximate)	Amount	Sources
Charlesgate	$ 2,500,000	
Back Bay Fens	$ 19,000,000	
Riverway	$ 3,700,000	
Leverett Pond	$ 2,700,000	
Willow Pond	$ 1,000,000	
Wards Pond	$ 2,200,000	
Contingency (20%)	$ 6,200,000	
Engineering & Permits (10%)	$ 3,100,000	
Construction Total	**$ 40,400,000**	
General Conditions (Project Wide)	$ 2,800,000	
Total	**$ 43,200,000**	Federal, state, and local contributions

For a more thorough discussion of the cost breakdown, refer to Section 6.0 in the Master Plan.

Description of the Project's consistency with state, municipal, county, regional and Federal growth and infrastructure plans and policies and of its ability to facilitate sustainable economic development:

The Emerald Necklace Environmental Improvements Master Plan is consistent with applicable state and federal growth, infrastructure plans and policies. The proposed project will enhance the hydraulic capacity of the Muddy River, minimize flood occurrences, improve water quality, restore aquatic and riparian habitat, lessen the risk of flood-related damage, and restore a significant and historic resource of the Town of Brookline, the City of Boston, and the Commonwealth.

List of any permits, licenses, certificates, variances or approvals required from any municipal, county, regional or Federal governmental entity:

It is expected that elements of the Emerald Necklace Environmental Improvements Master Plan will require compliance with the rules and regulations stipulated within a number of federal, state, and local environmental laws which include the following:

ENVIRONMENTAL PERMITS

Federal

National Environmental Policy Act (NEPA)
Section 404(b)(1) of the Clean Water Act
National Pollutant Discharge Elimination System (NPDES) Discharge permit

State

Massachusetts Environmental Policy Act (MEPA)
Chapter 91 (314 CMR 9.00) (Waterways Regulations)
Section 401 Water Quality Certification
Massachusetts Wetlands Protection Act
Rivers Protection Act Amendment to the Wetlands Protection Act

Local

Determination Of Applicability (RDA)
Notice of Intent (NOI)
Order of Conditions (OOC)

HISTORICAL/ARCHAEOLOGICAL PERMITS

Federal

Section 106 Review

State

Determination of No Adverse Impact (Massachusetts Historical Commission review and approval required)

Local

Boston Landmark Commission
Town of Brookline Preservation Commission

For a more detailed description of all environmental permits, reference Section 4.0 within the Emerald Necklace Environmental Improvements Master Plan (Attachment 4).

Certifications:

1. **The Public Notice of Environmental Review has been/will be published in the following newspapers in accordance with 301 CMR 11.15(1):**

(Name)	**(Date)**
The Boston Herald	1/29/99

2. **This form has been circulated to Agencies and Persons in accordance with 301 CMR 11.16(2).**

1/22/99 — **Date** — **Signature of Responsible Officer or Proponent**

Justine Liff, Commissioner
Name (print or type)

Firm/Agency Boston Parks & Recreation Dept.

Street 1010 Massachusetts Ave.

Municipality/State/Zip Boston, MA 02118

Phone (617) 635-4505

1/25/99 — **Date** — **Signature of person preparing ENF (if different from above)**

Jason M. Cortell, Principal-in-Charge
Name (print or type)

Firm/Agency Jason M. Cortell and Associates Inc.

Street 244 Second Avenue

Municipality/State/Zip Waltham, MA 02451-1177

Phone (781) 890-3737 (x 120)

Attachments:

1. ENF schedule as indicated on Page 4 of this form.
2. Original U.S.G.S. map (8-½ x 11 inches) indicating the Project location and boundaries.
3. 401 Water Quality Certification Form (BRP WW 07, 08 Dredging)
4. Emerald Necklace Environmental Improvements Master Plan

Schedule 1 -- Land (attach additional pages if necessary)

1. Description and assessment of the Project's impacts on land, including (as applicable):

A. acres of land to be altered directly

Approximately 48 acres of (saturated) land will be impacted through dredging (see page 12-1.A of this form for a breakdown of this acreage). Additional impacts to uplands will include impacts sustained during the movement of dredging equipment along the dredging access areas and upland sites modified for dredged material dewatering.

B. acres of new impervious area to be created

N/A

C. acres of public natural resources land to be converted to other purposes

N/A

D. acres of land in agricultural use (with agricultural soils) to be converted to nonagricultural use

N/A

E. release of a conservation restriction, preservation restriction, agricultural preservation restriction or watershed preservation restriction

N/A

F. required approval of a new urban redevelopment project or a fundamental change in an existing urban redevelopment project

N/A

G. required approval of a new urban renewal plan or a major modification of an existing urban renewal plan

N/A

2. Description and assessment of the Project's other impacts on land:

Regardless of the dredging method, a staging area (s) for trucks and equipment, equipment for separating sediment from water, mixing lime and sediment and filtration of return water will be necessary. Should hydraulic and/or Eddy Pump dredging take place, it is possible that a larger staging location (s) will be needed for sediment and water separation devices and filtration of return water. Although the extent of the staging areas will be further defined during design, it is expected that the former Sears parking lot and other minimally vegetated and accessible areas would be used.

Laydown areas will be required along the entire length of the Muddy River wherever equipment will be operating. It is easier to determine where dredging equipment will not be allowed to operate due to significant vegetation that is to be protected. A preliminary delineation of the areas of significant vegetation that are to be protected during dredging will be provided in the Phase I EIR.

3. **Description and analysis of alternative plans or designs for the Project or aspects thereof that would avoid or minimize impacts on land:**

The impacts to land sustained during the proposed dredging, the movement of the dredging equipment, and the establishment of staging/laydown areas will be mitigated using standard NRCS methodology, Best Management Practices (BMP's), the flagging of sensitive upland areas, and the restriction of dredging equipment from these upland areas.

It is anticipated that the current information on avoidance and the minimization of wetland impacts will be significantly refined and documented during the Phase I EIR process.

4. **Description and assessment of proposed measures that would mitigate impacts on land:**

Improvements to existing surface drainage patterns through the implementation of BMP's and the stabilization of the banks of the Muddy River will improve existing conditions through a reduction in flooding and solids loading from the erosion of developed and parkland areas. A preliminary BMP analysis would include, for example, the elimination of illegal connections to storm drains and contaminated groundwater into the storm drains, sediment traps, degritting structures, and permanent erosion and sediment controls such as vegetated filter strips, grassed swales, and constructed urban runoff wetlands. Furthermore, it is recommended that street sweeping and cleaning of catch basins also take place.

In addition, replanting and natural revegetation activities are planned to enhance the environmental quality of the Emerald Necklace. During the construction, a thorough, site-specific sediment erosion control plan will be developed and implemented so as to effectively minimize impacts. This information will be presented in greater detail in the Phase I EIR. It is critical however that any BMP proposed in the Phase I EIR not be intrusive and blend with the historic and visual aspects of the park.

Further analysis of BMP's at tributary locations will be conducted in the Phase I EIR.

Schedule 2 -- Rare Species (attach additional pages if necessary)

1. **Description and assessment of the Project's impacts on rare species, including (as applicable):**

   A. **alteration of "significant habitat" designated by the Natural Heritage and Endangered Species Program in accordance with General Laws Chapter 131A**

   There are no designated "significant habitat" areas within the project area.

   B. **taking of an endangered or threatened species or species of special concern**

   The presence of the threespine stickleback (*Gasterosteus aculeatus*) (Threatened) has been documented within the Natural History Pools of Olmsted Park and the spotted turtle (*Clemmys guttata*)(Special Concern) has been documented within the vicinity of Leverett Pond (Section 2.4 - Master Plan). Consequently, the responses of the MNHESP will determine whether or not any work can be performed in this area, and if so, will indicate any special mitigation measures to be taken.

   C. **alteration of a Priority Site of Rare Species Habitat and Exemplary Natural Communities alteration of Estimated Habitat of Rare Wildlife or a Certified Vernal Pool**

   Based upon the Massachusetts Natural Heritage Atlas (1997-1998 Edition), a priority site of rare species habitat will be directly impacted by the proposed dredging within Ward's Pond, Willow Pond, and Leverett Pond. Before any work can begin within this area, written notification of the scope of the project will be sent to MNHESP. Their responses will indicate whether or not any work can be performed in this area, and if so, will designate any special mitigation measures that need to be taken.

2. **Description and assessment of the Project's other impacts on rare species:**

The threespine stickleback, which is a state listed threatened species (MNHESP, 1998) occurs within one of the Natural History Pools which drains into Willow Pond and constitutes the southernmost land locked population on the east coast. The natural history pools are small, permanently inundated, depressions, most likely of anthropogenic origin, and which are a tributary to Willow Pond (Olmsted Park). Apparently, the loss of open water habitat within the pools may be contributing to a decline in the population size of the threespine stickleback. Although the Emerald Necklace Master Plan calls for the restoration of these pools, which would invariably restore some of the open water habitat within the pools, the impacts to the lowered population size of the threespine stickleback may be of significance.

3. **Description and analysis of alternative plans or designs for the Project or aspects thereof that would avoid or minimize impacts on rare species:**

Alternative plans and designs that would minimize impacts to the rich habitat diversity within Olmsted Park and the species that occupy this patchy mosaic will be developed so as to effectively:

- Preserve and enhance existing habitat structural and areal diversity;
- Identify the areal extent of the species of concern, their seasonal movement patterns (turtle movement) and general habitat preferences.

This information will be based upon intensive field investigations, which will be formulated and discussed within the Phase I EIR.

Before any work can begin within the Olmsted Park Area, written notification of the scope of the dredging project will be provided to MNHESP. Their responses will dictate whether or not any work can be performed in this area, and if so, will indicate any special mitigation measures to be taken.

4. Description and assessment of proposed measures that would mitigate impacts on rare species:

Of the entire Muddy River system, Olmsted Park offers the widest range of aquatic and terrestrial habitats and within which both threatened species and species of special concern have been identified. A sound mitigation plan will be developed that will, at a minimum:

- Preserve and enhance existing habitat structural and areal diversity;
- identify the areal extent of the species of concern, their seasonal movement patterns (turtle movement) and general habitat preferences.

This information will be based upon intensive field investigations, which will be formulated and discussed within the Phase I EIR.

Before any work can begin within the Olmsted Park area, the results of the field studies, the proposed mitigation plan, and written notification of the scope of the dredging project will be sent to MNHESP. They will determine whether or not any work can be performed in this area, and if so, will indicate whether the mitigation measures proposed are adequate.

Schedule 3 -- Wetlands, Waterways and Tidelands (attach additional pages if necessary)

1. **Description and assessment of the Project's impacts on wetlands, waterways and tidelands, including (as applicable):**

A. alteration of any resource area subject to protection under the Wetlands Protection Act

Direct alteration of resource areas will occur under the proposed dredging and infrastructure improvement plan and will involve impacts to approximately 48 acres of wetland area (ACOE, 1998). Of this total, an estimated 85% is composed of land under water bodies and waterways and approximately 15% is composed of bordering vegetated wetlands (BVW) and bank.

Impacts to federal, state, and local statutory interests will involve the following resource types:

- Buffer Zone
- Bordering Land Subject to Flooding (BLSF)
- Land Under Water Bodies and Waterways
- Bordering Vegetated Wetlands (BVW)
- Bank

B. alteration of any other wetlands protected under Federal or State law

No.

C. alteration of a wetland resource area requiring a variance under the Wetlands Protection Act

The project proponents will request a variance under the MA Wetlands Protection Act by the Boston and Brookline Conservation Commissions. In accordance with 310 CMR 10.05 (10):

> *"the variance is necessary to accommodate an overriding community, regional, state or national public interest.."*

The goals underlying this unique project are to enhance flood control by increasing the hydraulic capacity of the Muddy River and to recapture the spirit of Olmsted's original design which has been recognized as a landmark on the National Register of Historic Places.

D. construction or alteration of a dam

N/A

E. non-water dependent use of or structure in waterways or tidelands

No.

F. fill or structure in a velocity zone or regulatory floodway

No.

G. roadway, bridge or utility line to a barrier beach

N/A

H. dredging or disposal of dredged material

The available history of dredging in the Emerald Necklace indicates frequent dredging of Leverett Pond and none in the Riverway. A summary of the dredging history is as follows:

Leverett Pond

1898-1899	Removed sediment bar opposite the Village Brook drain in Brookline.
1930	Removed sediment bar opposite the Village Brook drain. This dredging was of limited extent and occurred 150 feet south of the drain inlet and left a pond depth of 1-3 feet and a center channel of 3.5 ft.
1943	The sediment bar had reappeared and was mapped for tracking.
1963	The entire pond was dredged to a depth of 5 ft. from the existing 0.5-1.0 ft.
1980	Sources do not indicate if the dredging ever took place even though it was funded.

Willow Pond

1963	Dredged to 7.5 ft from it's existing 2 ft. The stream to Leverett Pond was also dredged.

Ward's Pond

1963	The shoreline was dredged alone. The center of the basin was not dredged and was reported to be 7 ft. deep. The outlet stream was deepened by about one foot.

Muddy River/Back Bay Fens

1976	10,000 to 15,000 cu yds. hydraulically removed from in front of the Boston gate houses in a demonstration project.

In 1997, the USGS reported that the meandering parts of the Back Bay Fens to be approximately 1.6 feet deep with some locations of three feet.

The proposed dredging project has three components:

- Equipment mobilization and access;
- Dredging and dredged material dewatering/transportation /disposal
- Bank restoration and revegetation

Based upon the size of the areas to be dredged and accessibility, dredging activities within the Muddy River would most likely be conducted using a combination of techniques as follows:

- Drag Line dredging;
- Environmental clam shell bucket dredging
- Dredging by means of a track-mounted excavator;
- Hydraulic dredging
- Eddy Pump dredging

Drag Line Dredging

Dredging by means of a drag line may be conducted in areas where the equipment will not damage trees or other significant vegetation. Due to the swing of the crane boom and cable, the areas where a drag line could be used are limited to minimally treed and vegetated areas within the Back Bay Fens, such as the water's edge behind the Victory Gardens, Mothers Rest, the War Memorial, the Rose Garden, areas near Clemente Field, parts of Olmsted Park such as Leverett Pond, Willow Pond, and Wards Pond. A drag line would be effective in the pool located at the Boston gate housesin the Back Bay Fens.

A disadvantage to drag line dredging is that the operation leads to higher amounts of suspended solids as a result of the dragging of the bucket through the water.

Environmental Clam Shell Bucket Dredging

The use of environmental clam shell dredge buckets is becoming "state-of-the-art" in dredging projects where the protection of water quality and minimization of turbidity is of concern, as it is in the Muddy River. The environmental clamshell bucket has evolved from the standard open clam shell bucket to a new technology where the clam shell bucket has been equipped with the following features:

- Overlapping side plates to reduce lateral movement of material;
- A positive side lip sealing system;
- Passive venting to reduce downward pressure in the water column when lowering;
- Top covers to prevent washout and sloughing when raising;
- A clam shell bucket lock avoiding accidental discharge of bucket contents;
- Clam shell vibrators which remove all dredged material at the

receiving barge;
- Bucket seal alarm which indicates when jaws are not completely closed;
- A large flat dredge footprint;
- Horizontal cutting action which provides for a flatter dredge profile and eliminates pockets;
- Volume control;
- Barge mounted side scan imaging sonar; and
- Wash tank for the clam shell bucket.

As with drag line dredging, the use of the clam shell bucket is limited to areas where trees and other significant vegetation are not present. Due to the swing of the crane boom and cable, the areas where a clam shell bucket could be used are limited to minimally treed and vegetated areas within the Back Bay Fens such as the water edge behind the Victory Gardens, Mothers Rest, the War Memorial, the Rose Garden, areas near Clemente field, and sections within Olmsted Park such as parts of Leverett Pond, Willow Pond, and Ward's Pond.

The advantage to this dredging technology is that it can offer high capacity buckets that provide a reasonably cost-effective means of reducing suspended solids.

Dredging with Track-Mounted Excavators

Track-mounted excavators offer greater mobility within more restricted areas than do cranes. For example, longer arms can be installed to extend the excavator's reach and larger capacity buckets of a variety of configurations can be used. Such equipment would most likely be used in areas of the Back Bay Fens, the Riverway, Leverett Pond, Willow Pond, and Ward's Pond.

Because the bucket on the excavator cannot be covered, higher levels of turbidity could be caused. This however, could be offset by the greater precision of the dredging process and minimization of damage to the banks.

Hydraulic Dredging

Conventional hydraulic dredging involves the use of a barge or pontoon mounted control cab, a power plant to provide electrical and hydraulic power, a boom with a hydraulically operated cutter head, large capacity water pumps that pump the combination of water and sediment, and a discharge pipeline. This technology could be used within the Back Bay Fens, for example, in the area behind the Victory Gardens, in the pool at the Boston gate houses, and within Leverett Pond, which is situated in Olmsted Park. It may also be used in limited areas of the Riverway where wide pools and significant vegetation restricts the use of larger and potentially damaging equipment.

Because the hydraulic dredge operates by mixing the materials to be dredged with water usually at a ratio of four parts water to one part of dredge sediment - hence the term of hydraulic dredging, and then pumping the mixture out to a discharge point, the use of hydraulic dredging anywhere in the Emerald Necklace will require the use of additional means to separate the sediment from the water at the discharge point. This very well could include excavated and/or bermed settling basins,

classifiers, cyclones, and water filtration equipment. It could also include the means to reduce the water content of organic materials through lime mixing in order to meet landfill requirements. Mixing of the sediment with lime would also stabilize contaminants in the sediments. The coarser sediments in front of the Boston gate houses will settle much faster and would not require the use of all the separation equipment mentioned above.

Eddy Pump Dredging

Eddy pump dredging is a modified type of hydraulic dredging and consists of specially designed pump systems which allow the pumping of materials of up to 80 or higher percentages of solids. Conventional hydraulic dredging is the reverse where the solids content may only be 25 percent. Eddy pump dredging may also be less damaging to water quality because it minimizes the extraneous mixing of sediment and water which then would increase suspended solids. Eddy pump dredging in the Emerald Necklace could be used in locations where the amount of such solids as branches, shopping carts, steel, wood etc. is not present or is minimal, or can be removed prior to dredging.

Staging/Laydown Areas for Dredging

Regardless of the dredging method, staging/laydown areas for trucks and equipment, equipment for separating sediment from water, mixing lime and sediment and filtration of return water will be necessary. Should hydraulic and/or Eddy Pump dredging take place, it is possible that a larger location will be needed for sediment and water separation devices and filtration of return water.

Laydown areas will be needed along the entire length of the Muddy River wherever equipment will be operating. During design determinations will be made as to where certain vegetation must be protected during dredging and where vegetation can be removed to facilitate access.

Although the extent of the staging/laydown areas will be further defined during design, it is expected that the former Sears parking lot and other minimally vegetated and accessible areas would be used. The Back Bay yard is too small and congested to serve as an effective staging area.

2. **Solid fill, pile-supported or bottom-anchored structure in flowed tidelands or other waterways**

No.

3. **Description and assessment of the Project's other impacts on wetlands, waterways and tidelands:**

The proposed dredging project will provide significant habitat and water quality improvements to approximately 48 acres of degraded riparian and aquatic habitat. This includes the removal of approximately 7.4 acres of *Phragmites australis* stands within the Back Bay Fens and within the Riverway (CORTELL, 1995). Of this total approximately 1.6 acres occur landward of the bank and approximately 5.8 acres occur within the banks (CORTELL, 1995). Until a definitive wetland boundary has been established and a topographical/bathymetric survey conducted, the exact

quantification of the areal and linear extent of Land under Water, Bank, Bank Bordering Vegetated Wetlands, and Bordering Land subject to Flooding can only be approximated. It is assumed that the results of such surveys will be incorporated into the Phase I EIR.

Beneficial Impacts of Dredging

The most beneficial result of the proposed Phase I project would be to increase the hydraulic capacity of the Muddy River channel and to improve water quality. The effects of this would be to reduce the risk of flooding and property damage as experienced during the October 20-21, 1996 flood. The removal of accumulated sediment and organic matter through dredging would increase dissolved oxygen levels above 5 mg/l (ACOE, 1998) and also significantly reduce sediment oxygen demand (SOD) and recycling of nutrients at the sediment/water interface. Additionally, the removal of contaminants would result in improved water quality, increased biotic diversity, reduced odor levels, and improved water sheet aesthetics.

Dredging is the most positive control of invasive emergents (giant reed) due to the physical removal of plant matter, as well as, nutrient rich, soft-bottom sediments. The control of submersed aquatic vegetation (fanwort) will be achieved by excavating the channel/pond bottom to depths that correspond to the pre-industrial stream bed elevation.

Adverse Impacts of Dredging

The removal of accumulated sediments can be expected to produce temporary water quality impacts in the form of increased suspended solids, turbidity, and nutrient loading, nitrification, and the release of petroleum residues contained within the bottom sediments. Although the dissolved oxygen (DO) levels within the lower reaches of the Muddy River system are seasonally very low, dissolved oxygen levels may be depressed even further during the dredging process. This may result in some fish loss due to depressed DO levels. These temporary effects will be restricted to the period of dredging.

4. Description and analysis of alternative plans or designs for the Project or aspects thereof that would avoid or minimize impacts on wetlands, waterways and tidelands:

Several alternatives to bank-to-bank dredging have been proposed by various state and federal agencies. A preliminary analysis of alternatives is provided within section 5.2 of the attached Emerald Necklace Environmental Improvements Master Plan. These will be examined in the Alternatives Analysis of the Phase I EIR.

Potential alternatives to the proposed flood control and water quality improvements (see Master Plan sections 5.1.4, and 5.2) that might avoid and/or minimize impacts to wetlands vary with the volumes of bottom sediments removed. These alternatives include the following:

- Dredge a Single Channel within the Lower Fens Alone
- Dredge Selected Central Portions of the Muddy River Channel
- Dredge Leverett Pond and the Riverway
- Dredge Leverett Pond

- Dredge only the Back Bay Fens
- Dredge only the Riverway

These alternatives of scale will be fully analyzed as to their ability to meet the project goals of flood control, water quality improvements and habitat enhancement in the Phase I EIR.

5. **Description and assessment of proposed measures that would mitigate impacts on wetlands, waterways and tidelands:**

The dredging in the Muddy River is proposed to remove post-industrial age sediments and to expose natural soil deposits. The depths of the anthropogenic sediments are detailed in the USGS 1998 report.

Because the Muddy River is shallow and does not offer any potential for dilution of solids that are suspended in the water from the dredging action, measures to minimize the impacts to water quality are proposed and will be further expanded during project design and permitting. The following mitigation plan is proposed not only to minimize the impacts to the Muddy River, but to further minimize any impact to the Charles River.

It has to be recognized that given the existing shallow water in any of the areas to be dredged, combined with the sluggish flow of the Muddy River, that impacts from suspended solids will be high in the Muddy River itself. Therefore, the proposed water quality mitigation plan includes the following:

- Phased approach to the dredging;
- The selection of the least environmentally damaging dredging equipment and dredging plan;
- Deployment of silt curtains and booms; and
- Monitoring of water quality to assess the effectiveness of and correct problems with the water quality mitigation systems.

It is proposed that dredging and daylighting be phased as follows in order to provide an opportunity to actively minimize water quality impacts before the water reaches the Charles River. The phasing would first include the completion of the cleaning of the conduits between Ipswich Street and the Charles River. This area would provide a final location for settling before the water enters the Charles River.

The next phase of dredging would be to dredge upstream of the Agassiz Bridge through the Lagoon behind the Rose Garden. The purpose for this phase is to remove coarser and less problematic sediment and to provide opportunities to reduce turbidity by means of silt curtain deployment in the pools. The remainder of the dredging could then proceed in two prongs: In the area between Ipswich Street and the Agassiz Bridge (between the Victory Gardens, Mothers Rest, and the Duck House), and the balance of the Back Bay Fens and the Riverway.

In order to dredge the area between the Victory Gardens, Mothers Rest and the Duck House, it is proposed that the area be divided into three segments. The segments would be isolated by silt

curtains and would consist of the *Phragmites australis* stands along each side and the open water itself. The dredging of the *Phragmites australis* could be conducted with environmental clamshell buckets with the silt curtains trapping silt and floating debris. Dredging of the open water could proceed at the same time by mechanical or hydraulic means. Environmental clamshell dredging is proposed for this area due to the presence of sediments whose chemical characteristics exceed the TCLP regulatory threshold for lead.

Because the sediments upstream of the Rose Garden Lagoon have a higher organic content, suspended solids concentrations will be greater. Therefore, the provision of an extended settling basin within the Back Bay Fens at the Lagoon and in front of the Boston gate houses will facilitate the settling of solids. For both short and long term planning, it is also proposed that the dredging also include over-dredging at accessible locations. In order to preserve the historic character of the Emerald Necklace, it is proposed that the over-dredging be conducted to both facilitate the removal of solids and to retain the visual character of the park land. Settling basins could be dredged at accessible locations such as in the northern Basin between the Victory Gardens and the Duck House, the Southern Basin in front of the Boston gate houses, downstream of the stone bridge at Avenue Louis Pasteur, downstream of Brookline Avenue, upstream of the Riverway at the Back Bay Yard, in front of and downstream of the Tannery Brook outfall, in front of the Village Brook drain, at the main inlet to Leverett Pond, at selected inlets to Leverett Pond and the main inlet to Willow Pond. Such basins will provide for settling areas that can be reached in the future for easier removal of settled solids before they can enter the river system.

Because the former Sears parking lot offers the single and largest open area of land within the project site, it is proposed that this area be reserved for construction and potential dewatering uses. Daylighting of this area and reconstruction of the diversion structure would be conducted after all dredging of the Riverway system to Leverett Pond is completed.

The phasing of the upstream dredging will include the dredging of Ward's Pond, then Willow Pond, and finally Leverett Pond.

During design and permitting, some selection of the dredging equipment will be made and measures to mitigate impacts to wetlands and water quality will be designed further.

Schedule 4 -- Water (attach additional pages if necessary)

1. **Description and assessment of the Project's impacts on water resources, quality, facilities and services, including (as applicable):**

   A. new or expanded withdrawal from a groundwater or surface water source

   N/A

   B. new interbasin transfer of water

   N/A

   C. new water mains

   N/A

   D. new water service by an Agency of the Commonwealth to a municipality or water district

   N/A

   E. new or expanded drinking water treatment plant

   N/A

   F. alteration requiring a variance under the Watershed Protection Act

   Yes.

   G. non-bridged stream crossing 1,000 or less feet upstream of a public surface drinking water

   N/A

   H. supply for purpose of forest harvesting activities

   N/A

2. **Description and assessment of the Project's other impacts on water resources, quality, facilities and services:**

   Although this project is expected to improve long-term water quality, there will be temporary adverse impacts to water quality associated with the dredging which will be more fully discussed in the Phase I EIR.

3. **Description and analysis of alternative plans or designs for the Project or aspects thereof that would avoid or minimize impacts on water resources, quality, facilities and services:**

   Alternatives to the proposed dredging and all mitigation will be will be more fully discussed in the Phase I EIR

4. **Description and assessment of proposed measures that would mitigate impacts on water resources, quality, facilities and services:**

Although this project will ultimately improve long-term flood control, water quality, and enhance aquatic/riparian habitat, there will be temporary adverse impacts associated with the dredging. Standard techniques for minimizing impacts to water quality can involve the use of special dredging methodology. For example, an environmental clam shell dredge bucket can be used in dredging projects where the protection of water quality and minimization of turbidity is of concern.

In that the dredging process and the disposal of contaminated sediments are subject to a number of strict guidelines, a preliminary assessment of available mitigating measures is provided in the following sections. All mitigating measures are designed to protect the immediate environment during the removal, treatment, and subsequent disposal of contaminated sediments excavated from the water bodies of the Emerald Necklace park system. A significantly more detailed mitigation plan will be provided in the Phase I EIR.

The overall objectives of the mitigation plan are:

- To protect the designated water uses and water quality standards of the Emerald Necklace water bodies and the contiguous wetland/littoral plant communities.
- To mitigate pollution from site runoff.

Dredging at most locations in the Emerald Necklace will require the use of additional means to separate the sediment from the water. These methods could include excavated and/or bermed settling basins, classifiers, cyclones and water filtration equipment. It could also include the means to reduce the water content of organic materials through lime mixing in order to meet landfill requirements. Locations where these activities are conducted will be protected by detailed erosion and sedimentation control plans, a Best Management Practices Plan and monitoring plans. The details of these plans will be specified during design and permitting.

Specific methods to minimize water quality impacts from return water, dewatering and runoff will include but not be limited to the following:

Approach/Access

It is anticipated that heavy equipment will access proposed dredging areas via pre-established routes which may or may not require the need for grading and/or filling of existing roadways. Any filling and/or grading activities as well as equipment and vehicle traffic not indicated in this report, will be the ultimate responsibility of the selected dredging contractor. BMP's necessary for the proposed mitigation activities will detail site-specific conditions and ensure that all efforts to mitigate impacts to the existing property and/or wetland vegetation will be detailed.

Environmental Monitoring

Environmental monitoring will have to be conducted during the dredging phase through direct water quality monitoring and monitoring compliance with all permit conditions. This work will be

conducted as part of an overall mitigation plan in accordance with the Boston and Brookline Conservation Commissions, 401 Water Quality Certification from the Department of Environmental Protection, and the NPDES permit from the Environmental Protection Agency. Any instances of exceedance or compliance failures will have to be reported to the Boston and Brookline Conservation Commissions.

Removal/Dewatering of Dredged Material

Based upon the bulk sediment analysis conducted within the Muddy River system by the ACOE (1996) and the USGS (1998), it is known that a majority of the sediments within the Muddy River system are contaminated and that some can be classed as hazardous material (see Section 5.2.2 of Attachment 4). Consequently, dewatered sediment from the Muddy River will require disposal at a DEP-approved, lined landfill. Excavated material may be trucked to onsite dewatering/dredged material treatment area (s).

Since offsite disposal is required, it is possible to limit dredged material placement to only the dewatering areas at each dredging location. In each case and after being dewatered, dredged material would be directly removed to an offsite DEP-approved landfill, thus allowing the temporary dewatering storage area to be revegetated and returned to pre-construction conditions. In that the Sears parking area is being proposed as a dewatering site, and will ultimately be excavated to facilitate the removal of the twin underground culverts, revegetation of the site is not a pressing issue.

Use of an onsite primary dewatering/storage area will involve the excavation of up to one to two feet of substrate prior to use. The excavated material will be manipulated around the perimeter of the storage area to form a berm which will contain dredged materials and control runoff.

Operation and Maintenance Responsibilities

The selected dredging contractor will be responsible for providing and maintaining all equipment and materials specified to achieve permit conditions for the duration of the contract. Materials that become degraded and are replaced (e.g. haybales, sorbent devices, and filter materials etc.) shall be properly disposed of according to applicable Federal, State, and local regulations. The selected contractor will also have to provide for immediate access to any BMP unit for operation, maintenance, and inspection requirements.

Stormwater/Dewatering/Surface Water Control

Affected catch basins shall be protected from stormwater runoff with geotextile fabric/hay bales, and sorbent devices. If stormwater collects and is pumped from an area, it shall first pass through an appropriately sized and outfitted sedimentation/fractionation tank. At all times, crushed stone and haybales/filter fabric shall be placed around sumps.

Geotextile Fences

Geotextile fences will be used in all locations as necessary to prevent sediment from being conveyed via surface runoff to any waterway or drainage structure. The silt fences and anchoring equipment will

have to be regularly maintained to provide erosion protection for the duration of the dredging process.

Check Dams

Site runoff control shall also be instituted by the placement of crushed stone and/or haybale check dams. The check dams shall be placed along existing or constructed swales and areas of potential shallow concentrated flows and surface depressions to reduce the migration of sediment. Water which is impounded behind the check dams shall be pumped into sedimentation tanks for settling and possible further physical, mechanical and/or chemical treatment prior to discharge. Accumulated sediment shall be removed and the check dams maintained as often as necessary to ensure their continued operation.

Deployment and Maintenance of Silt Curtains

The dredging of bottom sediments will result in the resuspension of sediment which would temporarily reduce water clarity/quality in the dredged areas of the water bodies associated with the Muddy River system.

To contain the resuspended particulates, silt curtains with windows which extend the full depth of the water column and into the sediment will be deployed around each increment of dredging related work. Silt curtains will also be installed around temporary discharge points, dredge bucket wash tanks, and other sources of turbidity.

The silt curtains should be inspected for tears and maintained weekly or more frequently as necessary and will be arranged so as to:

- Totally enclose the work site in such a manner that the construction process will not be impeded and turbid water will be contained.
- Maintain firm contact with the river substrate.

Access Limitations to Existing Park Lawns and Mature Tree Areas

The movement of heavy equipment (i.e. track excavators and trucks) will be restricted to established paved /gravel roads within and adjacent to the dredge sites. Every effort will be extended to avoid unnecessary damage to mature trees and their root systems through soil compaction. These efforts can include flagging individual trees or arranging orange snow fence in a protective circle at the drip line. Should mature trees become damaged by heavy equipment, an assessment of the damage will be made and corrective measures will be taken.

Odor Control

Topical applications of lime slurry may be necessary to control odors from dredged material before it is transported from temporary dewatering locations.

Wheel Washing Stations

Wheel washing station will be established at each point of egress from construction staging and dewatering sites.

Table 2 Previously Determined Sediment Quality (U.S.G.S., 1997) and Proposed Sediment Sampling (Cortell, 1998).

Samp. No.	Sampling Location	Sample Parameters USGS (1997)	New Testing
	Ward's Pond		
1	Inlet	Not Sampled	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
2	Center	Not Sampled	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
3	Outlet	Not Sampled	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
	Willow Pond		
4	Inlet	Not Sampled	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
5	Center	Not Sampled	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
6	Outlet	Not Sampled	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
	Leverett Pond		
7	Inlet	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
8	Center	TM, OCP, TPH, PAHs, TOC,TCLP	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
9	Outlet	Not Sampled	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
10	At Tannery Brook Drain	Not Sampled	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
11	Brookline Avenue Bridge	Not Sampled	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
	Muddy River		
12	Approx. 480' northeast of the Tannery Brook Drain	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
13	Approx. 220' northeast of the Longwood Avenue Drain	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
14	Approx. 100' north-northeast of the Longwood Ave. Bridge	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
15	Approx. 220' northeast of the Footbridge	TM, OCP, TPH, PAHs, TOC, TCLP, PCBs	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
	Back Bay Fens		
16	Adjacent and prior to the Brookline Gatehouse	TM, OCP, TPH, PAHs, TOC, TCLP, PCBs	TM, OCP, TPH, PAHs, TOC,TLP, PCBs
17	Between Brookline Avenue Gatehouse and Emmanuel College Drain (Overflow)	TM, OCP, TPH, PAHs, TOC, TCLP, PCBs	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
18	Approx. 220' southeast of the Fen Bridge	TM, OCP, PAHs,TCLP	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs

Table 2 (continued) Previously Determined Sediment Quality (U.S.G.S., 1997) and Proposed Sediment Sampling (Cortell, 1998).

Samp. No.	Sampling Location	Sample Parameters USGS (1997)	New Testing
19	Southwestern side of lagoon area & approx. 80' east-northeast of western footbridge	TM, OCP, PAHs,TCLP	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
20	Approx. 90' north of Stony Brook Overflow (Boston Gatehouse No. 1)	TM, OCP, PAHs,TCLP	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
21	Approx. 40' south of the Agassiz Bridge	TM, OCP, PAHs,TCLP	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
22	Approx. 340' east-northeast of the Agassiz Bridge	TM, OCP, PAHs,TCLP	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
23	Approx. 600' south of the Boylston Street Bridge	TM, OCP, PAHs,TCLP	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs
24	Approx. 160' south of the Boylston Street Bridge	TM, OCP, TPH, PAHs,TCLP	TM, OCP, TPH, PAHs, TOC,TCLP, PCBs

Acronyms are defined as follows:

TM (Trace Metals)
- Pb- Lead
- Hg- Mercury
- Ni- Nickel
- Zn- Zinc

OCP (Organochlorine pesticides)
- Aldrin
- Alpha-bhc
- Beta-bhc
- Delta-bhc
- Gamma-bhc
- Alpha-chlordane
- Gamma-chlordane
- Chlordane (Tech)
- DDD
- DDE
- DDT
- Dieldrin
- Endosulfan I
- Endosulfan II
- Endosulfan sulfate
- Endrin
- Endrinaldehyde
- Endrin ketone
- Heptachlor
- Heptachlorepoxide
- Methoxychlor
- Toxaphene

PAHs (Polyaromatic hydrocarbons)
- Acenathene
- Acenaphylene
- Anthracene
- Benzo(a) anthracene
- Benzo(b) fluoranthene
- Benzo(k) fluoranthene
- Benzo(a) pyrene
- Benzo(ghi) perylene
- Biphenyl
- Chysene
- Bebenzo (a.h.) anthracene
- Fluoranthene
- Fluorene
- "Indeon(1,2,3-cd)pyrene"
- Naphthalene
- 2-Methyl-Napthalene
- Phenanthrene
- Pyrene

TCLP (Toxicity characteristic leaching procedure)
- Silver
- Arsenic
- Barium
- Cadmium
- Chromium
- Mercury
- Lead
- Selenium

TPH (Total petroleum hydrocarbons)
TOC (Total organic carbon)

Schedule 5 -- Wastewater (attach additional pages if necessary)

1. **Description and assessment of the Project's wastewater impacts, including (as applicable):**

   A. **new or expanded wastewater treatment and/or disposal facility**

   N/A

   B. **new interbasin transfer of wastewater**

   N/A

   C. **new sewer mains**

   N/A

   D. **new sewer service by an Agency of the Commonwealth to a municipality or sewer district**

   N/A

   E. **new or expanded discharge of sewage, industrial waste water, or untreated stormwater to an outstanding resource water, a sewer system, surface water, or groundwater**

   N/A

   F. **new or expanded capacity for storage, treatment, processing, combustion or disposal of sewage sludge, sludge ash, grit, screenings, or other sewage sludge residual materials**

   N/A

2. **Description and assessment of the Project's other wastewater impacts:**

   N/A

3. **Description and analysis of alternative plans or designs for the Project or aspects thereof that would avoid or minimize wastewater impacts:**

   N/A

4. **Description and assessment of proposed measures that would mitigate wastewater impacts:**

   N/A

Schedule 6 -- Transportation (attach additional pages if necessary)

1. **Description and assessment of the Project's impacts on traffic, transit, pedestrian and bicycle transportation facilities and services, including (as applicable):**

   A. new or widened roadway

   N/A

   B. new interchange on a completed limited access highway

   N/A

   C. new airport

   N/A

   D. new or expanded runway, terminal, taxiway, or air cargo building at an airport

   N/A

   E. new rail or rapid transit line for transportation of passengers or freight

   N/A

   F. new generation of vehicle trips (average daily trips)

   N/A

   G. new parking spaces

   N/A

   H. construction, widening or maintenance of a roadway or its right-of-way that will alter the bank or terrain, cut living public shade trees, or eliminate stone wall

   N/A

   I. conversion of a military airport to a non-military airport

   N/A

   J. discontinuation of passenger or freight service along a rail or rapid transit line

   N/A

   K. abandonment of a substantially intact rail or rapid transit right-of-way

   N/A

2. **Description and assessment of the Project's other impacts on traffic, transit, pedestrian and bicycle transportation facilities and services:**

   The circulation of vehicular, pedestrian, and bicycle traffic may be temporarily affected by the movement of dredging equipment. This issue will be explored further in the Phase I EIR.

3. **Description and analysis of alternative plans or designs for the Project or aspects thereof that would avoid or minimize impacts on traffic, transit, pedestrian and bicycle transportation facilities and services:**

The circulation of vehicular, pedestrian, and bicycle traffic may be temporarily affected by the movement of dredging equipment. This issue will be explored further in the Phase I EIR.

4. **Description and assessment of proposed measures that would mitigate impacts on traffic, transit, pedestrian and bicycle transportation facilities and services:**

The circulation of vehicular, pedestrian, and bicycle traffic may be temporarily affected by the movement of dredging equipment. This issue will be explored further in the Phase I EIR.

Schedule 7 -- Energy (attach additional pages if necessary)

1. **Description and assessment of the Project's impacts on energy facilities and services, including (as applicable):**

   A. new or expanded electric generating facility

   N/A

   B. new fuel pipeline

   N/A

   C. new electric transmission lines

   N/A

2. **Description and assessment of the Project's other impacts on energy facilities and services:**

   N/A

3. **Description and analysis of alternative plans or designs for the Project or aspects thereof that would avoid or minimize impacts on energy facilities and services:**

   N/A

4. **Description and assessment of proposed measures that would mitigate impacts on energy facilities and services:**

   N/A

Schedule 8 -- Air (attach additional pages if necessary)

1. **Description and assessment of the Project's impacts on air resources and quality, including (as applicable):**

   A. **construction or modification of a major stationary source**

   N/A

   B. **new or increased emissions of particulate matter, carbon monoxide, sulfur dioxide, volatile organic compounds, oxides of nitrogen, lead, any other criteria or hazardous air pollutant, or carbon dioxide**

   It is anticipated that there will be temporary increases in localized CO levels associated with the operation of the dredging equipment and the trucking of dredged material offsite. Furthermore, the stockpiling of dredged material during the dewatering process may give off odors temporarily. The on-site treatment of dredged materials will be fully discussed in the Phase I/ EIR.

2. **Description and assessment of the Project's other impacts on air resources and quality:**

   N/A

3. **Description and analysis of alternative plans or designs for the Project or aspects thereof that would avoid or minimize impacts on air resources and quality:**

   N/A

4. **Description and assessment of proposed measures that would mitigate impacts on air resources and quality:**

   N/A

Schedule 9 -- Solid and Hazardous Waste (attach additional pages if necessary)

1. **Description and assessment of the Project's solid and hazardous waste impacts, including (as applicable):**

   A. **new or increased capacity for the storage, treatment, processing, combustion or disposal of solid waste**

   N/A

   B. **new or increased capacity for the storage, recycling, treatment or disposal of hazardous waste**

   N/A

2. **Description and assessment of the Project's other solid and hazardous waste impacts:**

   The dredging and disposal of contaminated bottom sediments will be discussed more fully in the Phase I EIR.

3. **Description and analysis of alternative plans or designs for the Project or aspects thereof that would avoid or minimize solid and hazardous waste impacts:**

   The dredging and disposal of contaminated bottom sediments at DEP-regulated land disposal sites will be discussed more fully in the Phase 1 EIR.

4. **Description and assessment of proposed measures that would mitigate solid and hazardous waste impacts:**

   The dredging and disposal of contaminated bottom sediments will be discussed more fully in the Phase I EIR.

Schedule 10 -- Historical and Archaeological Resources (attach additional pages if necessary)

1. **Description and assessment of the Project's impacts on historical and archaeological resources, including (as applicable):**

   A. **demolition of all or any exterior part of any Historic Structure listed in or located in any Historic District listed in the State Register of Historic Places or the Inventory of Historic and Archaeological Assets of the Commonwealth**

   No. The project will not affect any historic resource listed on the State Register of Historic Places or on the MHC Inventory of Historic Assets of the Commonwealth. The Proponent commits to protecting existing historic resources which ultimately will be restored or added to in ways that would preserve their historic character.

   B. **destruction of all or any part of any Archaeological Site listed in State Register of Historic Places or the Inventory of Historic and Archaeological Assets of the Commonwealth**

   N/A

2. **Description and assessment of the Project's other impacts on historical and archaeological resources:**

   N/A

3. **Description and analysis of alternative plans or designs for the Project or aspects thereof that would avoid or minimize impacts on historical and archaeological resources:**

   As described earlier in this notification form, one of the goals of this plan is to restore many of the cultural and functional aspects of the Emerald Necklace Park system. Consequently, it is not anticipated that any adverse impacts to historical or archaeological resources would occur. This will be discussed in greater detail within the Phase I EIR.

4. **Description and assessment of proposed measures that would mitigate impacts on historical and archaeological resources:**

   N/A

Schedule 11 -- Areas of Critical Environmental Concern (attach additional pages if necessary)

1. **Description and assessment of the Project's impacts on environmental resources or quality or infrastructure facilities and services within an Area of Critical Environmental Concern that are conceptually or physically related to the subject matter of any Permit required for the Project:**

   N/A

2. **Description and assessment of the Project's other impacts on environmental resources or quality or infrastructure facilities and services within an Area of Critical Environmental Concern:**

   N/A

3. **Description and analysis of alternative plans or designs for the Project or aspects thereof that would avoid or minimize impacts on environmental resources or quality or infrastructure facilities and services within an Area of Critical Environmental Concern:**

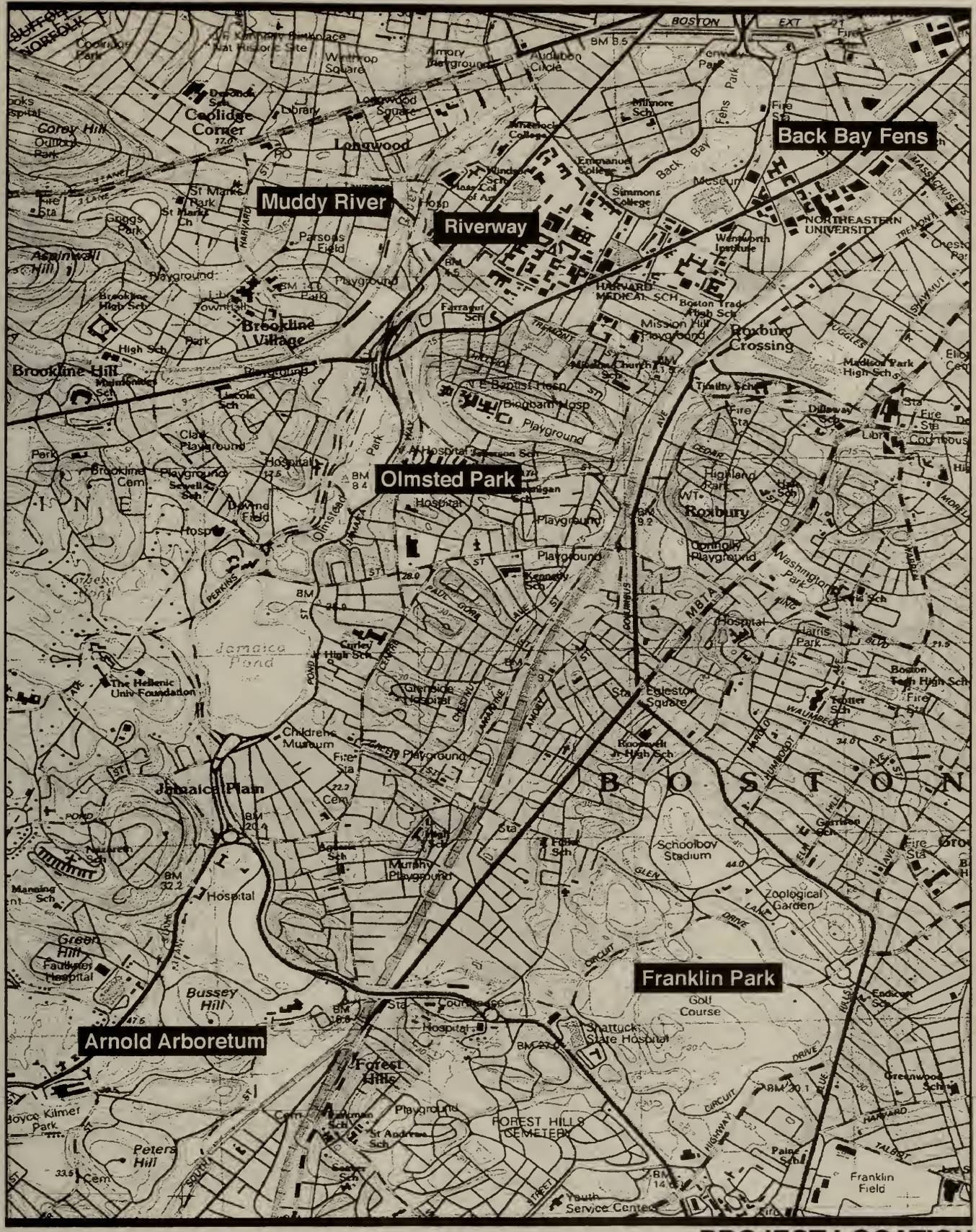
   N/A

4. **Description and assessment of proposed measures that would mitigate impacts on environmental resources or quality or infrastructure facilities and services within an Area of Critical Environmental Concern:**

   N/A

Attachment 2

U.S.G.S. Quadrangle Sheet/ Project Location Map



PROJECT LOCATION

SOURCE: U.S.G.S. (1987)

Boston Parks and Recreation Department

Emerald Necklace Environmental Improvements Master Plan

Environmental Notification Form

Boston, Massachusetts

0' 2083'

Figure 1

CORTELL ASSOCIATES

Attachment 3

BRP WW07, 08 Dredging 401 Water Quality Certification Application

Massachusetts Department of Environmental Protection
Bureau of Resource Protection – Wetlands and Waterways

Transmittal #

BRP WW 07, 08 Dredging

401 Water Quality Certification - Projects Proposing More Than 100 Cubic Yards Dredging or Disposal of Dredged Material

A Applicant Information

1. Which permit category are you applying for?
   ■ BRP WW 07 ☐ BRP WW 08

2. Applicant:

Boston Parks & Recreation Department
Name
1010 Massachusetts Avenue
Address
Boston MA, 02118
City/Town State
Frances G. Beatty, Sr. Landscape Architect
Contact Person
(617) 635-4505
Telephone (home) (work)

3. Authorized agent:

Jason M. Cortell and Associates Inc.
Name
244 Second Avenue
Address
Waltham MA, 02451
City/Town State
Jason M. Cortell, Principal-in-Charge
Contact Person
(781) 890-3737 (x111)
Telephone (home) (work)

B Project Information

1. Project Location:

The Emerald Necklace
Street Address
Boston/ Brookline
City/Town
Muddy River, Scarboro Pond
Nearest or Adjacent Waterbody

2. Project Name (if any):

Emerald Necklace Improvements Master Plan & Phase 1
Muddy River Flood Control, Water Quality and Habitat Enhancement

3. Will the proposed project occur in any wetlands or waters designated as "Outstanding Resource Waters"?

☐ yes ■ no

If yes has public notice been published in the Environmental Monitor?

☐ yes ■ no

Date of Publication

4. Identify the loss in square feet of each type of resource area (see Application Instructions for additional information.):

a. Land under water
The dredging will *affect* approximately 1,873,080 ft² of Land under Water and convert 322,344 ft² of giant reed stands to aquatic habitat.
square feet

b. Other Resources:
The proposed dredging will *affect* and restore approximately 38,800 lf of Bank.
square feet

5. Does this project require a license from the Federal Energy Regulatory Commission?

☐ yes ■ no

If yes, see Application Instructions for additional information needed.

6. Is the project categorically subject to MEPA?

■ yes ☐ no

If yes, has final action been taken?

☐ yes ■ no

If yes, please include copy of MEPA certificate.

7. Is any of your proposed work exempt from the Massachusetts Wetlands Protection Act or taking place in a federal non-state wetland?

☐ yes ■ no

If yes, see Application Instructions for additional information needed.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection – Wetlands and Waterways

Transmittal #

BRP WW 07, 08 Dredging

401 Water Quality Certification - Projects Proposing More Than 100 Cubic Yards Dredging or Disposal of Dredged Material

C Description of Proposed Dredging Site

1. a. Describe in general the proposed project or activity, including the purpose and intended use of the project, and the duration of the work within any waterbody:

The bank-to-bank dredging of the Muddy River system will enhance hydraulic capacity, water quality, remove nuisance vegetation, improve wildlife habitat, and promote the recreational use of the Emerald Necklace parklands.

b. Date activity to commence:

September1999

c. What is the expected frequency of maintenance dredging of this project? Explain:

It is recommended that the Muddy River system be dredged once every 10-20 years. It is expected that this dredging interval will change.

2. Attach plan(s) of the proposed project as follows:

■ Include a copy of the appropriate portion from the USGS quadrangle map for this project site. Include the identification number and name of the USGS quad map. (see attachment 2)

Plan View.
The plan view of the proposed activity should show the following:

☐ Existing shorelines.

☐ Ebb and flood in tidal waters and direction of flow in rivers. N/A

☐ North arrow.

☐ Graphic and numerical scale.

☐ Mean high and low water lines if the proposed activity is located in tidal areas. N/A

☐ Ordinary high water line for inland water.

☐ Water depths around the project.

☐ Principal dimensions of the structure or work and extent of encroachment beyond the applicable high water line.

☐ Seaward distance from an existing permanent fixed structure or object N/A

☐ Distance between proposed activity and navigation channel, where applicable. N/A

☐ Harbor lines, if established and if known. N/A

☐ Location of structures, if any, in navigable waters immediately adjacent to the proposed activity. N/A

☐ Location of any vegetated wetlands or wetland resource area.

☐ Proximity to any designated Areas of Critical Environmental Concern.

Elevation and/or Section View.
The elevation and/or section view of the proposed project should show the following:

☐ Same water elevations as in the plan view.

☐ Depth at waterward face of proposed work. Show dredging grade.

☐ Graph and numerical scale.

☐ Cross-section of excavation including approximate side slopes.

3. a. What is the length, width, depth and volume of the proposed project?

length:	width:
Approximately 26,400 ft.	Varies
Feet	Feet

Depth:	Volume:
Varies	Approximately 171,900 cu.yds.
Feet	cubic yards

b. Is the proposed project considered

i. a new project, ☐ yes ■ no or

ii. maintenance of an existing project? ■ yes ☐ no

iii. when was the project area last dredged?

See ENF Schedule 3 for a dredging history.

Date

Permit/License Name and Number

BRP WW 07, 08 Dredging

401 Water Quality Certification - Projects Proposing More Than 100 Cubic Yards Dredging or Disposal of Dredged Material

C Description of Proposed Dredging Site (cont.)

3. c. Describe in complete detail the physical dredging operation including descriptions of the type of dredge equipment, i.e., hopper dredge, hydraulic dredge, etc., the type of transportation to be used from the dredge site to the disposal site, the method of release of the dredged material into the disposal site, and the name of the contractor if other than the applicant.

Dredging activities within the Muddy River would most likely be conducted using the following techniques:

1. Drag Line dredging;
2. Environmental clam shell bucket dredging;
3. Dredging by means of a track-mounted excavator;
4. Hydraulic dredging; and
5. Eddy Pump dredging.

It is anticipated that dredged material will be trucked from the site. In that dredged material disposal will not involve release into an ocean disposal site, the method of release is not applicable

(see ENF Schedule 3) .

d. Describe all measures designed to avoid and minimize adverse impacts of the project on aquatic life and the aquatic ecosystem. Where impacts cannot be avoided or minimized, what mitigation measures are proposed? (See Application Instructions.)

Efforts to minimize impacts to aquatic life and the aquatic ecosystem sustained during the dredging and construction in the buffer zone will involve, at a minimum, standard Soil Conservation Service sediment erosion control devices, i.e. geotextile fabric, haybales and standard dredging mitigation protocols, i.e. silt curtains. Although this project will ultimately improve long-term water quality, there will be temporary adverse impacts associated with the dredging. Standard techniques for minimizing impacts to water quality involve the use of special dredging methodology. For example, an environmental clam shell dredge bucket can be used in dredging projects where the protection of water quality and minimization of turbidity is of concern **(see ENF Schedules 3 and 4 for additional information).**

4. Historical Parameters

To the best of your knowledge, does the proposed project area have any past history of:

a. chemical or oil spills or discharge?

■ Yes ☐ No

b. upstream or on-site industrial or municipal discharge within 1,000 feet of the proposed project?

■ Yes ☐ No

c. chronic pollutant loading from port or harbor use and/or other sources of pollutants? (eg. CSO or POTW discharges)

■ Yes ☐ No

If yes to any questions in Item C-4, provide as much historical information as you have, including dates, amounts, concentrations, etc. of such spills or discharge. Attach additional sheets if necessary.

Point-source discharges of pollutants into the Muddy River have included, amongst others, occassional combined sewer overflow surcharges during storm events, discharge of sanitary waste from the 16" Francis Street siphon, and in 1987, the accidental release of 4,500 gallons of heating oil into a branch of the Huntington Avenue drain which entered the Muddy River under the Route 9 bridge. Another source of oil to the river has been from leaking underground storage tanks.

BRP WW 07, 08 Dredging

401 Water Quality Certification - Projects Proposing More Than 100 Cubic Yards Dredging or Disposal of Dredged Material

D Description of Material to be Dredged

1. Grain Size Analysis

See application instructions for sampling and analysis requirements

Grain-size analysis data collected by the United States Geological Survey (1997) are presented in the attached pages. Grain-size analysis was performed using ASTM Method D422-63 (American Society for Testing and Materials, 1980).

Size Fraction	% of total by weight
coarse gravel 64 mm	see attached
fine gravel 2-64 mm	see attached
sand .063-2 mm	see attached
silt .004-063 mm	see attached
clay .004 mm	see attached

2. Chemical Analysis of Sediment

See application instructions for sampling and analysis requirements. List constituents in mg/kg (ppm) dry weight unless otherwise indicated.

(see attached)

Concentrations of trace metals, organic compounds, total organic carbon, and toxicity characteristic leaching procedure were analyzed in streambed sediment samples collected at 15 sites in the Muddy River (USGS, 1998).

Trace metals analyses were performed in accordance with sample preparation method 3050B and ICP method 6010B (U.S. Environmental Protection Agency, 1996, rev.1 and 2).

Mercury analyses were performed in accordance with method 245.5 (U.S. Environmental Protection Agency, 1983).

Organochlorine pesticides and polychlorinate biphenyls sample analyses were performed in accordance with the EPS Multi-Medial Consensus Organics Protocol-Revised 8/87. A macro-Florisil column was used for the sample cleanup. The analysis was carried out using high resolution capillary column chromatography. The 30-m dual capillary system consists of J&W DB-1701 and J&W DB-5, both with a 0.25 mm ID and a 0.25 micrometer fil thickness. (Peter Philbrook, EPA, personal communication, 1997).

Polyaromatic and total petroleum hydrocarbons sample analyses were performed according to EPA Region 1 procedure for Polyaromatic Hydrocarbons in Sediment Samples PAHSELL 1.SOP. The extracts were analyzed on a gas chromatograph/mass spectrometer using the selected ion monitoring (Dick Siscanaw, EPA, personal communication, 1997).

arsenic	see attached	
cadmium	see attached	
chromium	see attached	
copper	see attached	
lead	see attached	
mercury	see attached	
nickel	see attached	
zinc	see attached	
PCBs (polychlorinated biphenyls)	see attached	
PAHs (polynuclear aromatic hydrocarbons)	see attached	
TPH (total petroleum hydrocarbons)	see attached	
TOC (total organic carbon)	see attached	%
volatile solids	see attached	%
water	see attached	%

BRP WW 07, 08 Dredging

401 Water Quality Certification - Projects Proposing More Than 100 Cubic Yards Dredging or Disposal of Dredged Material

E Description of the Disposal Site for Dredged Material

1. For ocean disposal sites

a. Location of proposed disposal site and its physical boundaries.

Not Applicable (N/A)

b. Has the site been designated by the state or E.P.A. as a dredge disposal site? ☐ Yes ☒ No

If no, give a description of the characteristics of the proposed disposal site and an explanation as to why no currently designated site is feasible for this project.

(N/A)

c. Is the anticipated disposal site located within a designated ocean sanctuary as established by federal law or G.L.c. 132A, sec. 13? ☐ Yes ☒ No

If yes, which sanctuary?

(N/A)

2. For disposal sites or dewatering sites on land (landward of mean high water, see instructions):

a. Location of proposed disposal and dewatering sites and physical boundaries.

b. Indicate drainage characteristics of dewatering and disposal sites from the results of test pits, borings, percolation tests as applicable.

It is proposed that all excavated materials be disposed of at a DEP-approved landfill. A dredged material dewatering site may be located within the former Sear's Parking lot. A preliminary analysis of the physical properties of dewatering sites may include a quantification of sediment hydraulic conductivity, and an assessment of sediment textural and structural properties. More detail on dewatering site characteristics is provided in **ENF Schedules 3 and 4.**

c. How long are the dewatering and disposal sites estimated to be in use from this project? from future projects?

Approximately 12 months.

d. Include plans for effluent control at the dewatering and disposal sites.

3. For proposed dewatering of dredged sediment on a barge, **provide plans for adequate containment and effluent control.**

F Certification

Application is hereby made for Water Quality Certification concerning the activities described herein. I certify that I am familiar with the information contained in this application, and that to the best of my knowledge and belief such information is true, complete, and accurate. I further certify that I possess the authority to undertake the proposed activities.

Date

The application must be signed by the applicant; however, it may be signed by a duly authorized agent (named in Item 2) if this form is accompanied by a statement by the applicant designating the agent and agreeing to furnish upon request, supplemental

U.S. Department of the Interior
U.S. Geological Survey

Prepared in cooperation with the
Fenway Alliance,
U.S. Environmental Protection Agency,
Massachusetts Department of Environmental Management,
City of Boston, Department of Parks and Recreation,
Town of Brookline, Department of Public Works

Tables to Accompany Water-Resources Investigations Report 98-4027

Channel Morphology and Streambed-Sediment Quality in the Muddy River, Boston and Brookline, Massachusetts

By ROBERT F. BREAULT, PETER K. WEISKEL, and TIMOTHY D. McCOBB

USGS
science for a changing world

Marlborough, Massachusetts
1998

SUPPLEMENTAL DATA

Concentrations of trace metals, organic compounds, total organic carbon, grain-size distributions, percentage of moisture, and toxicity characteristic leaching procedure were analyzed in streambed sediment samples collected at 15 sites in the Muddy River, Massachusetts, in October 1997. These data can be used in conjunction with those presented on the accompanying map report to assist in the design of a remedial program for Muddy River sediments such a program might consider including the advisability of sediment removal, and optimal disposal and re-use options for the dredged sediments.

REFERENCES USED IN SUPPLEMENTAL DATA TABLES

American Public Health Association, American Water Works Association, and Water Pollution Control Association, 1995, Standard methods for the examination of water and wastewater, 19th ed: Washington, D.C., APHA (variously paginated)

American Society for Testing and Materials, 1980, Natural Building Stones; Soil and Rock: Annual Book of ASTM Standards, part 19, Philadelphia, 634 p.

U.S. Environmental Protection Agency, 1983, Methods for chemical analysis of water and wastes: U.S. Environmental Protection Agency, Cincinnati, Ohio, EPA-600/4-79-020, March 1979, Revised March 1983.

_____1992, Test methods for evaluating solid waste, physical/chemical methods SW-846, 3rd ed., vol. IC, Chap. 8, sec. 8.4, rev. 0, final update, 7/92.

_____1996, Test methods for evaluating solid waste, physical/chemical methods: SW-846, 3rd ed., Rev. 1 and 2, final update I, 7/92 and final update III, 12/96.

Table 1. Geographic distribution of trace metals and organic compounds in sediment cores, Muddy River, Massachusetts, October 1997

[All concentrations are in parts per million. **Trace metals:** Analyses were performed in accordance with sample preparation method 3050B and ICP method 6010B (U.S. Environmental Protection Agency, 1996, rev. 1 and 2). **Mercury**: Analyses were performed in accordance with method 245.5 (U.S. Environmental Protection Agency, 1983). **Organochlorine pesticides and polychlorinate biphenyls**: Sample preparation was done by the EPS Multi-Medial Consensus Organics Protocol-Revised 8/87. A macro-Florisil column was used for the sample cleanup. The analysis was carried out using high resolution capillary column chromatography. The 30-m dual capillary system consists of J&W DB-1701 and J&W DB-5, both with a 0.25 mm ID and a 0.25 micrometer fil thickness (Peter Philbrook, Office of Measurement and Evaluation Division of the U.S. Environmental Protection Agency, Region I, written commun., 1997) . **Polyaromatic and total petroleum hydrocarbons:** Sample analysis was performed according to EPA Region I Procedure for Polyaromatic Hydrocarbons in Sediment Samples PAHSELL1.SOP. The extracts were analyzed on the gas chromatograph/mass spectrometer using the selected ion monitoring Dick Siscanaw, Office of Measurement and Evaluation Division of the U.S. Environmental Protection Agency, Region I, written commun., 1997) . D, duplicate split sample; No., number; e, estimated; <, less than method detection limit]

	TRACE METALS							
Station No.	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Nickel**	**Zinc**
1	<40	3	122	203	919	1.4	29.3	574
2	<60	<2.7	41.3	240	657	1.2	29.2	527
3	<30	5	91.9	281	1,100	2	39.6	557
4	<30	<2.8	23.1	116	210	e6	18.4	225
5	<20	<2.7	49.5	148	532	1.4	24.8	276
5-D	<25	<3.0	56.7	169	590	1.3	27.8	310
6	<30	6	112	448	925	2.3	43.2	879
7	<60	<2.6	37.9	225	360	1	31.6	481
8	<30	<2.8	26.6	85.7	156	1.4	15.5	220
9	<45	8.3	344	710	1,320	6.3	70.6	1,070
10	<60	14.8	182	574	979	3.3	59.9	982
11	<25	6.9	66.3	389	1,270	2.8	37.3	778
12	<30	8.2	101	416	1,370	2.6	45.5	880
13	<35	8.9	78.6	478	1,410	3	44.6	882
14	<30	7.9	87.6	387	1,360	3.2	40.1	794
15	<50	9.7	78.2	605	1,260	2.5	44.8	965

Table 1. Geographic distribution of trace metals and organic compounds in sediment cores, Muddy River, Massachusetts, October 1997—*Continued*

ORGANOCHLORINE PESTICIDES

Station No.	Aldrin	Alpha-bhc	Beta-bhc	Delta-bhc	Delta-bah	Gamma-bah	Alpha-chlordane	Gamma-chlordane	Chlordane (Tech)	"4,4'-DDD"	"4,4'-DDE"
1	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.038	0.03	<2.0	3.2	0.23
2	.022	<.007	<.007	<.007	<.007	<.007	.023	<.007	<.7	.37	.16
3	<.01	<.01	<.01	<.01	<.01	<.01	.11	.091	<.1	2	.26
4	<.01	<.01	<.01	<.01	<.01	<.01	.035	.019	<.1	.56	.12
5	<.01	<.01	<.01	<.01	<.01	<.01	.041	.035	<.1	1.12	.099
6	<.01	<.01	<.01	<.01	<.01	<.01	.12	.096	<.1	.5	.16
7	<.008	<.008	<.008	<.008	<.008	<.008	.008	<.008	<.8	.026	.011
8	<.003	<.003	<.003	<.003	<.003	<.003	.0069	<.003	<.3	.046	.012
9	<.02	<.02	<.02	<.02	<.02	<.02	.088	.096	<.2	1.3	.38
10	<.01	<.01	<.01	<.01	<.01	<.01	.041	.04	<.1	.62	.31
11	<.01	<.01	<.01	<.01	<.01	<.01	.081	.049	<.1	.63	.17
12	<.02	<.02	<.02	<.02	<.02	<.02	.1	.062	<.2	.66	.19
13	<.02	<.02	<.02	<.02	<.02	<.02	.072	.05	<.2	.51	.16
14	.073	<.02	<.02	<.02	<.02	<.02	.089	.058	<.2	.63	.18
14-D	.075	<.02	<.02	<.02	<.02	<.02	.072	.051	<.2	.53	.14
15	.048	<.02	<.02	<.02	<.02	<.02	.053	.034	<.2	.29	.15

ORGANOCHLORINE PESTICIDES—*Continued*

Station No.	"4,4'-DDT"	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor	Heptachlor epoxide	Methoxychlor	Toxaphene
1	0.11	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<2.0
2	.038	<.007	<.007	<.007	<.007	<.007	<.007	.1	<.007	<.007	<.007	<.7
3	.05	.07	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.1
4	.033	.013	<.01	<.01	<.01	<.01	<.01	.095	<.01	<.01	<.01	<.1
5	.013	.015	<.01	<.01	<.01	<.01	<.01	.0093	<.01	<.01	<.01	<.1
6	.028	.039	<.01	<.01	<.01	<.01	<.01	.037	<.01	<.01	<.01	<.1
7	.021	<.008	<.008	<.008	<.008	<.008	<.008	.046	<.008	<.008	<.008	<.8
8	.013	<.003	<.003	<.003	<.003	<.003	<.003	.043	<.003	<.003	<.003	<.3
9	.055	.036	<.02	<.02	<.02	<.02	<.02	.056	<.02	<.02	<.02	<.2
10	.04	.015	.046	<.01	<.01	.026	<.01	<.01	<.01	<.01	<.01	<.1
11	.34	.05	<.01	.099	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.1
12	.028	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.2
13	.011	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.2
14	<.02	.057	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.2
14-D	<.02	.046	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
15	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02

Table 1. Geographic distribution of trace metals and organic compounds in sediment cores, Muddy River, Massachusetts, October 1997—*Continued*

Station No.	Aroclor								
	1016	1221	1232	1242	1248	1254	1260	1262	1268
1	<0.04	<0.04	<0.04	0.078	<0.04	<0.04	0.17	<0.04	<0.04
2	<.04	<.04	<.04	<.04	<.04	<.04	.11	<.04	<.04
3	<.04	<.04	<.04	.22	<.04	<.04	<.04	<.04	<.04
4	<.03	<.03	<.03	.081	<.03	<.03	.092	<.03	<.03
5	<.03	<.03	<.03	<.03	<.03	.14	.14	<.03	<.03
6	<.06	<.06	<.06	<.06	<.06	.43	.23	<.06	<.06
7	<.04	<.04	<.04	<.04	<.04	<.04	<.04	<.04	<.04
8	<.04	<.04	<.04	<.04	<.04	.04	<.04	<.04	<.04
9	<.06	<.06	<.06	.33	<.06	1.3	.93	<.06	<.06
10	<.06	<.06	<.06	.16	<.06	.77	.45	<.06	<.06
11	<.04	<.04	<.04	.56	<.04	1.7	.71	<.04	<.04
12	<.04	<.04	<.04	.57	<.04	2.2	.62	<.04	<.04
13	<.05	<.05	<.05	.67	<.05	1.7	.73	<.05	<.05
14	<.04	<.04	<.04	.6	<.04	1.9	.58	<.04	<.04
14-D	<.04	<.04	<.04	.67	<.04	1.7	.6	<.04	<.04
15	<.05	<.05	<.05	.43	<.05	1.6	.59	<.05	<.05

	POLYAROMATIC HYDROCARBONS								
Station No.	Acenaph-thene	Acenaph-thylene	Anthracene	Benzo (a) anthracene	Benzo (b) fluoran-thene	Benzo (k) fluoran-thene	Benzo (a) pyrene	Benzo (ghi) perylene	Biphenyl
1	1.7	0.43	3.8	13	19	7	13	8.7	0.077
2	1.9	.53	5.5	19	26	8	17	11	.087
3	1.2	.23	3.3	8.5	11	4	7.8	5.1	.085
4	5.2	.43	9.2	24	30	8.6	23	13	.34
5	.54	.13	1.3	4.5	6.2	2.4	4.3	3	<.045
6	.57	.23	1.6	6.1	9.5	3.6	6.3	4.9	<.084
7	.76	.48	3.3	12	18	6.1	11	7.9	.08
8	.46	.39	1.7	7.9	18	6.2	11	8.5	.059
9	2.9	.81	8	18	26	9.4	18	13	.44
10	.38	.2	.66	3.8	7.8	2.3	4.6	3.8	<.086
11	1.9	.36	3.5	11	15	5.7	11	6.9	.12
12	1.1	.3	2.3	8.9	13	5.1	8.8	6.2	.099
13	1.4	.37	2.8	9.3	13	5.3	8.8	6.1	.14
14	.96	.33	2.2	7.7	11	4.6	8.1	5.6	.1
14-D	1.5	.44	3.1	10	16	6.2	11	7.5	.14
15	1.1	.32	2.3	8.5	13	4.3	8.7	5.8	.14

Table 1. Geographic distribution of trace metals and organic compounds in sediment cores, Muddy River, Massachusetts, October 1997—*Continued*

	POLYAROMATIC HYDROCARBONS—*Continued*								
Station No.	Chrysene	Dibenzo (a.h) anthracene	Fluoran-thene	Fluorene	"Indeon (1,2,3-cd) pyrene"	Naph-thalene	2-Methyl-Naptha-lene	Phenan-threne	Pyrene
1	17	2.5	37	2.7	11	0.53	0.56	20	31
2	24	3.3	55	2.8	75	.41	.34	27	44
3	10	1.5	22	1.6	6.3	.5	.29	14	18
4	27	3.8	64	4.9	16	2.7	1.6	53	55
5	5.9	.8	12	.63	3.8	.17	.13	5.6	9.8
6	8.4	1.2	16	.99	5.7	.18	.43	8.2	14
7	16	2.2	32	1.3	10	.39	.28	11	26
8	12	2.2	19	.72	10	.27	.172	4.9	14
9	22	3	49	4	15	3	1.3	37	39
10	6.1	.86	10	.46	4.2	.27	.22	4.3	8.5
11	14	1.9	26	2.2	8.5	.49	1.2	20	23
12	12	1.5	23	1.5	7.3	.3	.34	14	20
13	12	1.5	24	2	7.3	.59	.55	16	21
14	10	1.5	20	1.3	6.7	.29	.43	11	18
14-D	14	2	25	1.9	9	.49	.51	17	23
15	11	1.5	21	1.5	7.1	.47	.51	13	19

Table 2. Geographic distribution of total petroleum hydrocarbon in sediment cores, Muddy River, Massachusetts, October 1997

[**Total petroleum hydrocarbons:** Concentrations are in parts per million. Standard analyses were performed in accordance with Methods for Chemical Analysis of Water and Wastes (U.S. Environmental Protection Agency, 1983), EPA-600/4/79-020, Test; Methods for Evaluating Solid Waste, SW-846 (U.S. Environmental Protection Agency, 1996), or standard methods for the examination of water and wastewater (American Public Health Association, 1995. D, duplicate split sample; No., number]

Station No.	Total petroleum hydrocarbon	Station No.	Total petroleum hydrocarbon
1	27,000	9	28,000
2	21,000	10	19,000
3	25,000	11	22,000
4	9,800	12	32,000
5	11,000	13	34,000
6	30,000	14	34,000
7	16,000	14-D	30,000
8	4,700	15	22,000

Table 3. Geographic distribution of total organic carbon in sediment cores, Muddy River, Massachusetts, October 1997

[All concentrations are in parts per million. **Total organic carbon:** Analyses were performed in accordance with New England Regional Laboratory Standard Operating Procedure (SOP) 14.1 using a Dohrmann DC-190 TOC Analyzer (William J. Andrade, Office of Measurement and Evaluation Division of the U.S. Environmental Protection Agency. Region I, written commun., 1997). D, duplicate split sample; No., number]

Station No.	Total organic carbon	Station No.	Total organic carbon
1	93,143	9	130,185
2	86,477	10	101,172
3	86,523	11	97,130
4	70,333	12	97,282
5	49,255	13	127,389
6	105,433	14	128,548
7	70,381	14-D	118,244
8	39,100	15	114,825

Table 4. Geographic distribution of grain size in sediment cores, Muddy River, Massachusetts, October 1997

[Grain-analysis was performed using ASTM Method D422-63 (American Society for Testing and Materials, 1980). **Gravel:** sieve number 4, greater than 4.75 millimeters. **Coarse sand:** Sieve number 10, less than 4.75 millimeters, greater than 2 millimeters. **Medium sand:** sieve number 40, less than 2.0 millimeters, greater than 0.425 millimeter. **Fine sand:** sieve number 200, less than 0.425 millimeter, greater than 0.075 millimeter. **Silt and clay:** less than 0.075 millimeter. D, duplicate split sample; No., number]

Station No.	Grain size (as percentage retained)				
	Gravel	Coarse sand	Medium sand	Fine sand	Silt and clay
1	0	0.4	12	28.1	57.4
2	1.3	8.67	29.3	23.4	37.4
3	.2	.4	10	37.7	51.7
4	1.9	6.6	34.7	33.5	23.3
5	2.1	7	24.5	39.7	26.7
6	.1	1.2	26.8	23.7	48.2
7	.4	5.4	31.6	24	61.4
8	6.4	11.5	44.6	22.9	14.6
9	0	4.1	31.1	22.2	42.6
10	.1	2.9	28.2	25.1	43.7
11	8	.2	10.1	60.3	29.4
12	.3	1.5	15.9	46	36.3
13	0	2.3	11.2	26.5	60
14	0	2.2	16.6	30.3	50.9
14-D	0	.5	16.3	31.2	52
15	0	.2	18.3	23.8	42.9

Table 5. Geographic distribution of percentage of moisture in sediment cores, Muddy River, Massachusetts, October 1997

[D, duplicate split sample; No., number]

Station No.	Percentage of moisture	Station No.	Percentage of moisture
1	58	9	73
2	56	10	71
3	56	11	54
4	43	12	61
5	45	13	64
6	70	14	58
7	58	14-D	59
8	50	15	40

Table 6. Geographic distribution of Toxicity Characteristic Leaching Procedure constituents in sediment cores, Muddy River, Massachusetts, October 1997

[**Trace metals:** Concentrations are in parts per million. TCLP was performed in accordance with method 1311 (U.S. Environmental Protection Agency, 1992). Sample preparation method 3010A and ICP method 6010B (U.S. Environmental Protection Agency 1996). **Mercury:** Only samples with a total mercury concentration of about 4 ppm or greater were analyzed. TCLP was perfomred in accordance with method 7470A (U.S. Environmental Protection Agency, 1996). D, duplicate split sample; No., number; <, less than method detection limit; --, not sampled]

Station No.	Silver	Arsenic	Barium	Cadmium	Chromium	Mercury	Lead	Selenium
1	<0.06	<0.25	0.43	<0.06	<0.03	--	1.1	<0.20
2	<.06	<.25	.56	<.06	<.03	--	1.4	<.20
3	<.06	<.25	.54	<.06	<.03	--	2.2	<.20
4	<.06	<.25	.4	<.06	<.03	<0.50	.76	<.20
5	<.06	<.25	.44	<.06	<.03	--	1.7	<.20
5-D	<.06	<.25	.47	<.06	<.03	--	1.8	<.20
6	<.06	<.25	.5	<.06	<.03	--	.79	<.20
7	<.06	<.25	.45	<.06	<.03	--	.28	<.20
8	<.06	<.25	.29	<.06	<.03	--	.7	<.20
9	<.06	<.25	.53	.06	<.03	<.50	1.8	<.20
10	<.06	<.25	.45	.14	<.03	<.50	.87	<.20
11	<.06	<.25	.46	<.06	<.03	--	1.2	<.20
12	<.06	<.25	.5	<.06	<.03	--	1.4	<.20
13	<.06	<.25	.51	<.06	<.03	--	1.3	<.20
14	<.06	<.25	.61	<.08	<.03	--	2.9	<.20
15	<.06	<.25	.64	<.10	<.03	--	2.8	<.20

Attachment 4

Emerald Necklace Environmental Improvements Master Plan

Boston Parks and
Recreation Department

The Emerald Necklace
Environmental Improvements Master Plan

JASON M. CORTELL AND ASSOCIATES INC.
PRESSLEY ASSOCIATES, INC.

December, 1998

December 23, 1998

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1.0 INTRODUCTION

1.1 PROJECT OVERVIEW

Jason M. Cortell and Associates Inc. (CORTELL), in association with **Pressley Associates, Inc.** has prepared this **Phase 1 Report** relevant to environmental improvements within the Emerald Necklace park system located in Boston and Brookline, Massachusetts.

Completed by Frederick Law Olmsted in 1895, the seven mile long Emerald Necklace was the first linear park to be constructed in this country, and is on the Register of Historic Places. Overall facility planning and management for the Emerald Necklace is a combined responsibility of the **Boston Parks and Recreation Department (BPRD)**, the **Brookline Department of Public Works (BDPW)**, and the **Metropolitan District Commission (MDC)**.

Frederick Law Olmsted ca. 1890's.

The Emerald Necklace system is comprised of a series of parklands and vehicular parkways, which are linked by the wetland resources of the **Muddy River system,** i.e. Back Bay Fens, Riverway, Leverett Pond, Willow Pond, Ward's Pond, Jamaica Pond, and those in **Franklin Park**, i.e. Scarboro Pond and Abbottspool (presently filled in), all of which are considered central features of the park. Over time, as a result of the changes in adjacent land use patterns associated with urbanization, water quality, hydraulic capacity, and the quality of both aquatic and riparian biota have become compromised.

1.1.1 Muddy River System

The most serious and intensely studied consequence of these changes is the presently diminished hydraulic and flood handling capacity of the Muddy River system, which has caused extensive structural damage to nearby properties and infrastructure.

The inability of the current Muddy River channel geometry to handle both increased flow velocities and volume was amply demonstrated in the early

autumn of 1996 (October 20-21) when a major storm event resulted in the total deposition of between 7.48 inches (Dorchester) and 10.72 inches (Brighton) of rain in the Boston area over a 36 hour period ($\bar{x}$ = 8.63 inches, n = 9) (ADS Environmental, 1996). The amount of rainfall associated with this storm exceeded the parameters associated with a 100 year storm event and caused the river to reach a record high flood stage, resulting in more than $70 million dollars in damage to residential, commercial, and public properties as well as Massachusetts Bay Transportation Authority subway facilities at Kenmore Square. This flood not only inflicted considerable damage and hardship upon property owners, but posed a threat to public health and the immediate environment as raw sewage surcharged from overtaxed combined sewer overflows (CSO's) onto local streets.

Flood occurrences within the Muddy River system have been largely attributed to system-wide constrictions, undersized conduits and elements of the area stormwater drainage system which include illegal sewer connections, combined sewer overflows (CSO's), and inoperative gatehouse flood controls (BWSC & MWRA, 1996).

Illegal sewer connections not only affect the area stormwater drainage system carrying capacity, but also augment flows to area sanitary sewers resulting in increased discharge to CSO's. According to the Muddy River Water Quality Improvement Plan (Metcalf & Eddy, September, 1990), 111 drainage outlets discharge sediment laden stormwater to the Muddy River waterway system.

Of these 111 drain outlets, eight major storm drains handle nearly 90% of the watershed sheet and conduit flow and discharge into the Muddy River (ACOE, 1992) (Figure 1). These eight outlets range in size from 4 inches on two bridge underdrains at the Route 9 crossing to four, 8' x 13' CSO's from the Stony Brook Conduit at Boston Gatehouse #1.

Muddy River- Major Drainage Outlets

SOURCE: ACOE (1992)

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Figure **1**

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Sediment Deposit at theVillage Brook Drain Outlet (Leverett Pond)

It is the influx of particulate matter and the spatial distribution of sediment deposition within the Muddy River system that have had the most profound effects on the ability of the Muddy River to handle peak stormflow.

In that the removal of bed material within the Muddy River system does not occur faster than it's accumulation due to it's inherent channel morphology and extreme solids loading, it is proposed that the entire Muddy River system be dredged from bank to bank. The dredging process, i.e. dredging and dredged material treatment, will require conformance with the rules and regulations stipulated within a number of anticipated Federal, State, and local permits which are discussed in greater detail in the permitting section of this report (Section 4.0).

While solids loading into the Muddy River system through stormwater flow will remain ongoing, the reduction of the total sediment load can be controlled through Best Management Practices (BMP's). These practices may include, but not be limited to, increased catch basin maintenance, street sweeping, and the installation and maintenance of modified major drainage outflows outfitted with sediment weirs, sediment traps/particle separators, and oil/ water separators. In that sixty-five percent of the Muddy River watershed is in Brookline, twenty-five percent is within the City of Boston and ten percent is within Newton (Blanc & Gregory, 1995), the burden of implementing and maintaining these structures will be a collective responsibility of all concerned parties.

In addition to the functional aspects, i.e. flood control, urban wildlife habitat, and passive recreation, there are aesthetic qualities that must also be considered in the park restoration design plan. Major shifts away from the original Olmsted design have occurred over time as a result of variation in local hydrology, a decrease in water quality, an increase in turbidity, and the establishment of invasive plant species.

Japanese knotweed (*Polygonum cuspidatum*), a species that thrives on disturbed, mesic sites, has out-competed more desirable vegetation, as has glossy buckthorn (*Rhamnus frangula*). Purple loosestrife (*Lythrum salicaria*), another species that thrives within disturbed wetland habitats has also started to establish along certain points of the Muddy River. However, of these species, the giant reed *(Phragmites australis*) dominates nearly all of the riparian corridor along the Back Bay fens and portions of the Muddy River, and has established further upstream, as evidenced by patchy clumps along the Riverway.

A number of interested parties and organizations have funded and conducted studies regarding the sedimentation and water quality problems within the Muddy River system and have developed recommendations to correct these problems. A partial list of Muddy River studies conducted from 1966-present is included in Attachment A of this report. Some of the more widely cited studies culled from this list include:

- **The Fenway Alliance:** This nonprofit assemblage of academic, cultural, medical, and religious institutions collectively produced a report entitled "*The Muddy River Restoration and Action Plan"* in 1997.

- **Walmsley/Pressley Associates, Inc.:** In 1989 and 1990, this joint venture produced an "Emerald Necklace Master Plan" and which was funded by the Department of Environmental Management (DEM).

- **Boston Water and Sewer Commission (BWSC) / Massachusetts Water Resources Authority (MWRA):** Through an initiative of BWSC, a study entitled "*CSO Elimination in Stony Brook Tributary Area*" was undertaken and towards which the MWRA allocated $ 45 million. In addition, BWSC conducted a "*Stony Brook Conduit Hydraulic Study*" which detailed repairs to the flood gates at Boston gatehouses 1 and 2, sediment removal at the gatehouses, and hydraulic studies that were modeled using different storm intensities/ return intervals.

- **U.S. Geological Survey (USGS) & U.S. Department of the Interior (DOI):** The USGS conducted an October, 1997 study entitled "*Channel Morphology and Streambed Sediment Quality in the Muddy River, Boston and Brookline, Massachusetts".* This study was prepared in

cooperation with the **Fenway Alliance, U.S. EPA, DEM, BPRD, and the Brookline DPW.**

- **U.S. Army Corps of Engineers (ACOE):** Conducted the *"Muddy River Feasibility Study, Boston and Brookline, Massachusetts"*. The study concluded that flow augmentation rather than dredging should be the first step taken in improving water quality within the Muddy River. The Corps considers dredging to be a "stopgap" measure with short lived benefits.

1.1.2 Franklin Park (Scarboro Pond and Abbottspool)

Scarboro Pond is a 7.1 acre impoundment situated within the rolling hills of Franklin Park. Originally designed by Olmsted in the late nineteenth century as part of the Emerald Necklace Park system, Scarboro Pond has brought a rich history of scenic vistas to this urban area and provided passive recreation for local residents.

The scenic vista afforded by Scarboro Pond is currently being threatened by the insults of eutrophication, which is a process whereby the influx of plant nutrients into an aquatic system, specifically both nitrates and phosphates, occurs at a rate that overcomes the ability of the system to process these levels. Eutrophication of lake and pond systems manifests itself in the explosive growth of those plant species that can tolerate these high levels, such as phytoplankton, and species of cyanobacteria (e.g. *Chroococcus spp.*, *Anabaena spp*, *Nostoc spp.* etc.) the presence of which can result in unsightly and foul smelling blooms.

Another threat to the integrity of Scarboro Pond is the deposition of fine sediment, which has contributed to the loss of water depth (particularly at the inlet)(Cortell, 1998), the reduction of the water retention capacity of the basin, shortened water residence times, and increased flushing rates. It is proposed that Scarboro Pond be dredged and that BMP's be implemented to control phosphate, nitrate, and sediment loading from golf course run off.

One other feature in Franklin Park is Abbottspool, located approximately northeast of Scarboro Pond. This area was once a 10 foot deep pond with an areal extent of 7-10 acres before it was filled in the early 1940's to facilitate the expansion of the golf course. Abbottspool now has the potential to be excavated and restored as a wetland resource and stormwater management.

2.0 PROJECT ELEMENTS

2.1 OVERVIEW

In 1988, Boston and Brookline completed their historic preservation Master Plan for the Emerald Necklace Park System (ENMP) and Franklin Park (FPMP). Over the past ten years, the municipalities and the state have undertaken many landscape restoration projects identified in both of these plans. In addition, many environmental engineering and limnological studies of the Muddy River system and Scarboro Pond have been completed and which are referenced in Attachment A.

As part of the BPRD's ongoing program of resource planning and management, a series of improvements regarding flood control have been identified for water features throughout the Emerald Necklace. Water quality problems within the Muddy River have been largely attributed to sluggish dry weather flows, combined sewer overflows (CSO's), illegal cross connection, high levels of sediment buildup and the explosive growth of invasive aquatic macrophytes (e.g. giant reed, fanwort etc.) (Blanc & Gregory, 1995).

Although there are a number of variables involved in fluvial hydraulics (e.g. bed material properties, cross sectional geometry, flow resistance, etc.), low flows within the Muddy River system occur primarily as a function of low bed slope angles and high levels of solids loading. These two factors have collectively resulted in the development of high levels of sedimentation within the Muddy River.

In most natural stream systems, sediment deposits are normally removed during periods of high flow. However, since the removal of bed material does not occur faster than the accumulation within the Muddy River due to it's inherent *channel morphology* and extreme solids loading, the entire Muddy River system requires dredging from bank to bank. The dredging process will serve to recreate the natural process of sediment removal, will contribute to the alleviation of the serious flooding problems, and will improve water quality within the Muddy River.

In that much of the sediment within the Muddy River System has been classed as being contaminated, this report includes a breakdown of sediment

analyses as conducted by the U.S.G.S. (1997) and the U.S. ACOE (1996), the details of which are presented in the Alternatives Analysis section of this report (Section 5.0).

2.2 BACK BAY FENS

Long before the changes in land use associated with industrialization, the Back Bay Fen was originally a salt marsh, dominated by extensive, monotypic stands of salt meadow grass (*Spartina patens*), and salt marsh cordgrass (*Spartina alterniflora*). Olmsted's original design attempted to maintain this salt marsh community prior to the construction of the Charles River Dam in 1910.

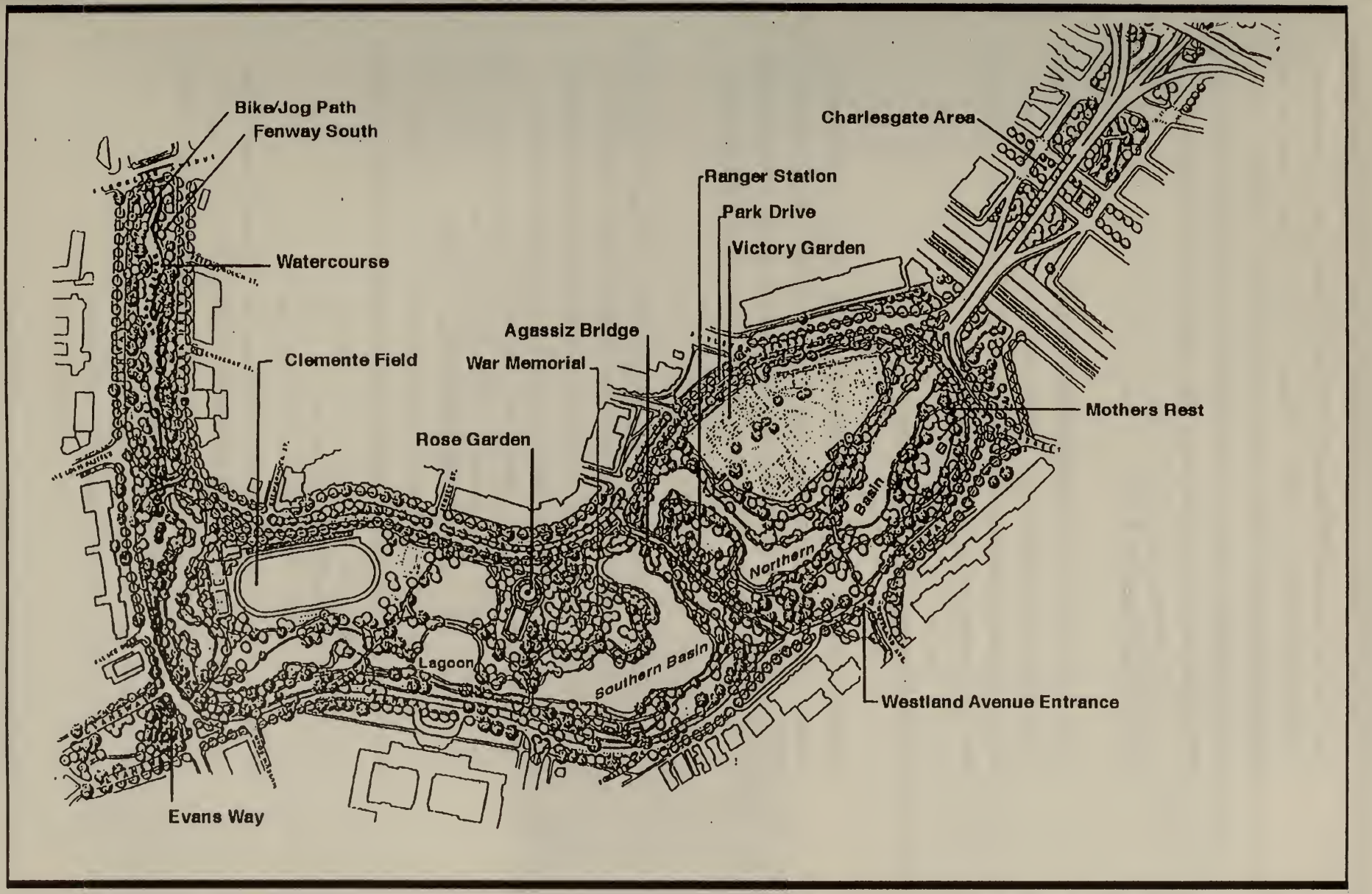
Giant Reed along the Back Bay Fens

The giant reed (*Phragmites australis*) is an aquatic plant species that thrives on disturbance, and is commonly found in salt marshes that have experienced a decrease in salinity concentrations. Within the Back Bay Fens, an influx of nutrients, low hydraulic gradients, a high degree of channel sinuosity, and an increase in the fine grained sediment load have contributed to the spread of this species. To correct these problems, it is proposed that the accumulated sediment load and invasive plant material be removed through dredging of the river. Additionally, landscape and architectural improvements will be implemented throughout the Back Bay Fens (Figure 2).

2.2.1 Watercourse

The restoration of the Muddy River channel focuses on the original areal extent of the river's footprint and increasing the present hydraulic radius (wetted perimeter)(Ward & Eliot, 1995). Increasing the hydraulic radius of the river channel should improve the hydraulic capacity and could facilitate the planting of a littoral fringe with historically and biologically meaningful wetlands vegetation. The littoral fringe will function to stabilize the banks, elevate wildlife habitat structural diversity, and food availability.

In addition to dredging, flood control systems are proposed which include a



Back Bay Fens Master Plan

SOURCE: Walmsley/Pressley (1986)

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Figure **2**

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flood warning system and repairs to the Charles River Dam. Furthermore, a water quality monitoring program and water quality improvements are recommended. These improvements may include particle/grit separators, oil/grease separators, improved surface drainage systems, improvements to the infrastructure, vegetated filter strips, and wetland treatment systems.

2.2.2 Charlesgate Area

Construction within the Charlesgate area may include a pedestrian/bicycle connection to the Charles River. The removal of culverts and stop dams within the Charlesgate Area will be included with the Muddy River infrastructure improvements.

2.2.3 Fenway South

Presently, within the vicinity of Emmanuel College, the Upper Fens Pond is a stagnant, shallow water body serviced by five (5) direct drainage outlets. The inherent low hydraulic gradient, underground culvert system and continued sedimentation has caused the Muddy River to severely bottleneck in this area.

The proposed improvements within Fenway South may include reopening the watercourse between Brookline avenue and Louis Pasteur. This work includes historically appropriate plantings that selectively buffer and open up views. In order to accommodate the reopening of the watercourse and maintain park continuity, the intersection at the former Sears parking lot may be reconfigured and may consider the elimination of the left turn loop at the intersection of Park Drive and Brookline Avenue. In addition, improvements to the drainage of surface waters will be achieved through an increase in curb settings and the implementation of Best Management Practices (BMP's).

2.2.4 Mother's Rest

Within the Mother's Rest area, the open space and the scenic views to the northern basin portion of the Back Bay Fens watercourse can be restored. This may necessitate the selective removal of mature trees, shrubs, and the complete removal of *Phragmites* stands.

2.2.5 Victory Gardens

The landscape within the immediate vicinity of the Victory Gardens is a degraded habitat with a number of ruderal upland/mesic plant species that are commingling with isolated patches of giant reed. The Victory Garden's area may be upgraded through riparian plantings, regrading, and improved management.

2.2.6 Park Drive

Restoration of the scenic views within the Park Drive area are proposed. This work strengthens the formal parkway plantings along the urban edge and the informal plantings within the park. Improvements to the infrastructure may also include increased curb settings and the implementation of BMP's.

2.2.7 Duck House

The Duck House is presently in disrepair, and is covered with spray-painted graffiti. The ENMP calls for the restoration of the Duck House at the Agassiz Bridge, the associated grounds, and closing the area off to vehicles. The structure could be utilized as a Ranger Station/Visitor Information Center.

2.2.8 Clemente Field

At Clemente Field, the ENMP recommends that the interior bleachers be removed and the basketball courts be relocated. The effect of these changes will be to open up the scenic vistas to the water and to reestablish the "reflecting quality" of the lagoon across from the Museum of Fine Arts.

2.2.9 Bicycle Path

A bicycle path on the east and south sides of the park is proposed which requires the regrading of the existing bridle path and establishing a paved bicycle route. This pathway will serve as an important link in the system-wide pathway system.

2.2.10 Westland Avenue Entrance

The Westland Avenue entrance may be enhanced through the addition of formal/ornamental landscape plantings. These plantings will serve to establish a definite boundary for the park at this entrance to the park system. Improving the stone dust pedestrian path behind the Fire Department Communications Center leading to Mother's Rest is recommended.

2.3 THE RIVERWAY

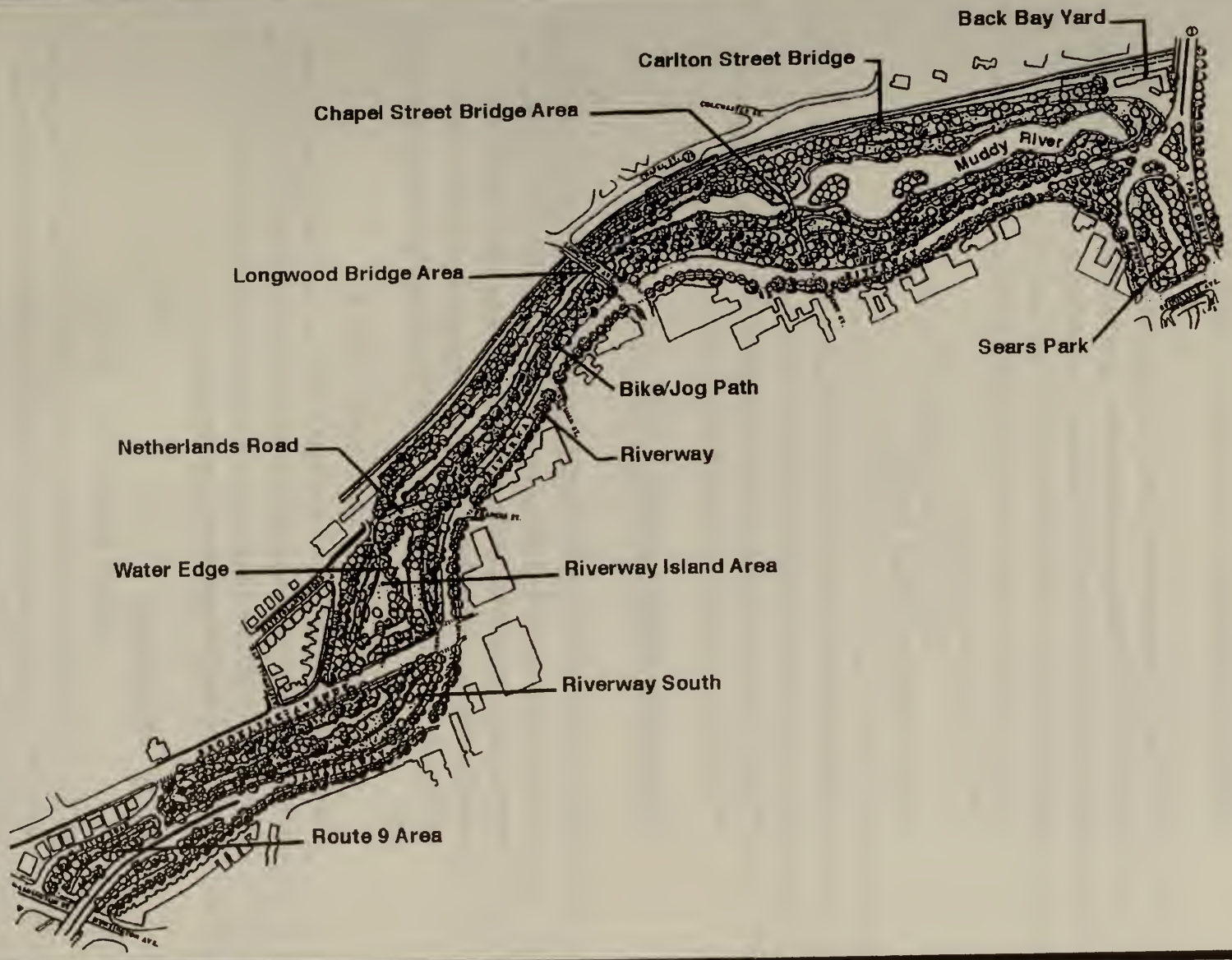
The Riverway is a narrow section of the Emerald Necklace that links Olmsted Park with the Back Bay Fens (Figure 3). Significant amounts of erosion and sedimentation can be observed within the more narrow sections of the Riverway and dense stands of *P. australis* have established along the banks of the Riverway which have further reduced the flow and flood carrying capacity of the Muddy River.

Historic View of Riverway

2.3.1 Watercourse

The object here, as in the Back Bay Fens, is to restore the natural flow of water and enhance flow rates, increase flow volumes, and improve water quality. The proposed dredging of the Muddy River will first increase the hydraulic capacity by increasing the hydraulic radius.

The issue of flood control can be addressed through the establishment of a flood warning system, the elimination of structural and other flow restrictions, the cleaning of the Muddy River diversion conduit , and the surveying and



Riverway Master Plan

SOURCE: Walmsley/Pressley (1986)

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Figure **3**

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restoration of the existing flood control berm between the Riverway and the MBTA tracks.

2.3.2 Sears Park

Restoration initiatives within Sears Park can include reestablishing the link between Brookline Avenue and the Back Bay Yard through the excavation and removal of the two 6' culverts that presently act as the hydraulic link between these two water bodies. Ultimately, this action will restore the historic Olmsted landscape within Sears Park and may serve to increase flood storage capacity slightly

2.3.3 Carlton Street Bridge

The Carlton Street pedestrian bridge presently arches over the MBTA tracks and is an advanced state of disrepair. The ENMP recommends that the bridge and it's surrounding landscape be restored. This may subsequently reestablish pedestrian access to the park system.

2.3.4 Chapel Street Bridge Area

The scenic shelter had it's roof repaired in 1989 and the ENMP recommends complete restoration. In conjunction with the restoration of the shelter, the immediately adjacent landscape should be restored using only Olmsted planting lists and plans. Additionally, existing mature vegetation will be judiciously pruned back to recreate views from the bridge and improve security.

Handicapped access to the Longwood MBTA stop will need to be improved and the repair of erosion around existing sidewalks. Historic lighting fixtures at the Chapel Street bridge between Longwood MBTA stop and hospital area may be installed to heighten the security level.

2.3.5 Riverway

Along the Riverway, formal plantings at the urban edge and informal plantings at the park edge are recommended through the use of ornamental shrubs, trees, and herbaceous plants. Additionally, improvements can be made to the surface drainage system by increasing curb settings, and implementing Best Management Practices (BMP's). Finally, historic light fixtures will be

introduced to this area to facilitate pedestrian traffic at night and also elevate the level of security.

2.3.6 Longwood Avenue Bridge Area

The Longwood Bridge landscape restoration uses only Olmsted plants and selectively removes existing vegetation to create scenic vistas. The pedestrian circulation on the Boston side of the Longwood Bridge may be improved by adding a series of steps. Longwood Avenue bridge may need masonry conservation.

2.3.7 Netherlands Road

The ENMP will investigate the closure of Netherlands Road and the bridge to all vehicular traffic. This should facilitate the safe passage of park visitors as they move between discontinuous park areas. Any proposed modifications to Netherlands Road will be fully coordinated with the Town of Brookline and will be given extensive public review.

2.3.8 Water Edge at Island Bridges

Ornamental shrub plantings and the meadow scenery at the waters edge near the island bridges are recommended to be recreated utilizing historic photos and planting plans. Finally , trees with an overhanging or "weeping" growth form are suggested to be planted along the edge of the river for a scenic effect.

2.3.9 Riverway Island Area

The restoration of the littoral fringe at the islands can consist of the removal of invasive aquatics and the stabilization of the banks with appropriate wetland plants. The islands can be replanted using only Olmsted planting lists and plans.

2.3.10 Riverway South

Within the Riverway South area, existing internal park pedestrian circulation from Netherlands Road to Huntington Avenue should be reconfigured so as to reclaim usable park land. Invasive vegetation such as Japanese knotweed (*Polygonum cuspidatum*) should be removed and the giant reed (*P.australis*)

can be excavated as part of the dredging process in an effort to enhance the scenic effect and the ability of the riparian zone vegetation to provide wildlife habitat. In addition, improvements to the local drainage system can entail an increase in curb settings, and the implementation of Best Management Practices (BMP's). Lastly, improvements can be made to the sidewalk on the Longwood Avenue bridge to facilitate the passage of park visitors.

2.3.11 Route 9 Area

As part of an overall park-wide effort to make the Emerald Necklace system more accessible to park visitors, the Metropolitan District Commission (MDC) has proposed traffic signalization at Route 9 which will be synchronized to facilitate the safe crossing of both pedestrians and cyclists.

2.4 OLMSTED PARK

Olmsted Park is a section of the Emerald Necklace that is very near to the source of the Muddy River (Figure 4). Although the general water clarity and plant species diversity within Olmsted Park appear to be somewhat higher relative to the downstream portions of the river system, significant amounts of sediment have been deposited within all of the major waterbodies.

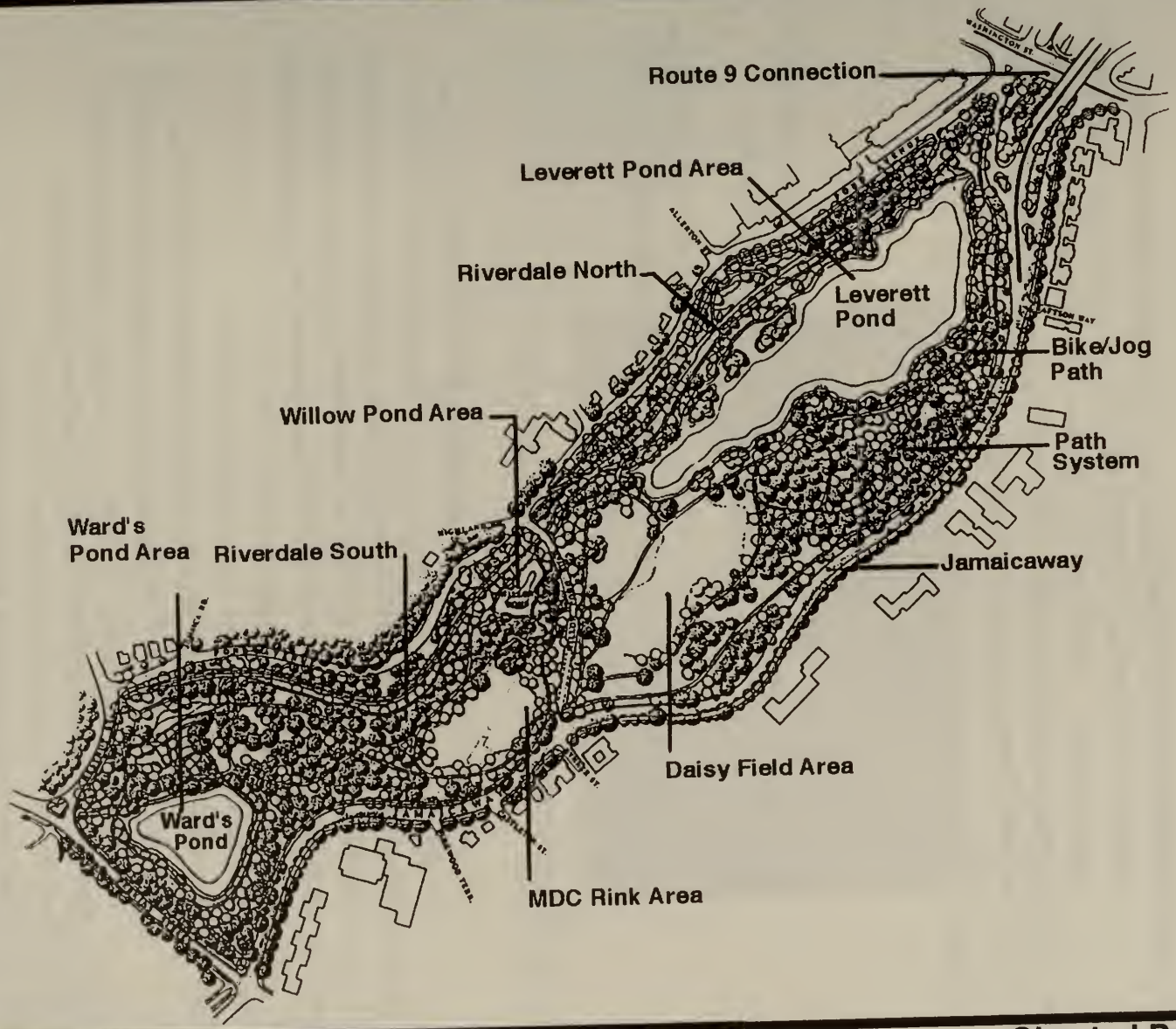
2.4.1 Leverett Pond Area

Historic scenic views on the Boston and Brookline sides of the Leverett Pond area can be restored through the selective pruning of existing vegetation and supplemental wetland and upland plantings.
The entire pond should be dredged, the historic inlet and pond banks on the Boston side be restored, and that the banks of the scenic islands along the Brookline side be replanted.

Improvements to infrastructure should consist of the inspection and, if necessary, repair of the gabion system, and the implementation of Best Management Practices (BMP's) for drainage at the sediment island that has developed at the mouth of the Village Brook drain.

2.4.2 Path System

The deteriorated path system between Willow Pond and Ward's Pond that



Olmsted Park Master Plan

SOURCE: Walmsley/Pressley (1986)

Boston Parks and Recreation Department

Emerald Necklace Environmental Improvements Master Plan

Phase I Report

Boston and Brookline, Massachusetts

Figure **4**

CORTELL ASSOCIATES

laces through Olmsted park will be upgraded and restored with a layer of stonedust.

2.4.3 Jamaicaway

Along the Jamaicaway, formal planting at the urban edge and informal plantings at the park edge can be achieved through the use of coniferous or deciduous trees. Additionally, improvements will be made to the surface drainage system by increasing curb settings, and implementing Best Management Practices (BMP's). Finally, historic light fixtures could be introduced along the parkway by the MDC.

2.4.4 Daisy Field Area

The Daisy Field ball diamonds should be reoriented so as to reduce impacts on the park and the light poles within the ball field should be painted black.

Surface runoff from the ballfields which is contributing to sedimentation within Leverett Pond should be controlled by improving field drainage systems and implementing BMP's.

2.4.5 Willow Pond Area

It is proposed that the excessive sediment buildup within Willow Pond be dredged to a recommended depth of 6 ft. This depth is based upon field investigations that revealed accumulated sediment depths of approximately 9 ft. within the vicinity of the inlet. In support of this, Metcalf & Eddy (1990) also reported excessive sediment buildup within the inlet and recommended that the inlet alone be dredged.

Conversely, the Emerald Necklace Master Plan recommends that the entire pond basin be dredged. The proposed uniform dredge depth of six feet will allow for the future trapping of the influx of sediment and improved water quality than would a shallower dredge depth or a partial dredging.

Once the dredging process has been completed, shrubs and other approved wetlands species that follow the Olmsted planting plan should be planted along the edges of the pond to increase the wildlife habitat structural diversity.

2.4.6 MDC Rink Area

An open meadow including native grasses and forbs should be recreated at the former MDC rink site.

2.4.7 Riverdale South from Chestnut Street to Willow Pond Road

The "babbling brook" should be restored by redirecting flow through the now dry channel. Furthermore, improvements to surface drainage will be attained

Wards Pond

by increasing curb settings and implementing Best Management Practices.

2.4.8 Ward's Pond Area

The shoreline of Ward's Pond was last dredged in 1963, while the remainder of the basin remained untouched. Previous studies have recommended that approximately 10,000 cu. yds. of bottom sediments would have to be removed from Ward's Pond (Metcalf & Eddy, Sept. 28, 1990). The Emerald Necklace Environmental Improvements Master Plan recommends that the sediment buildup within Ward's Pond should be dredged to a recommended depth of 4 ft for a total of 19, 340 cu.yds.

Once the dredging process has been completed, and invasive submerged and emergent aquatics removed, other approved wetlands plants should be planted along the edges of the pond to enhance existing wildlife habitat structure and diversity.

In addition, historic waterfalls, bridges, and the "babbling brook" leading out of the pond should be restored. Existing bridges and stairs should be restored,

and additional bridges should be constructed to restore the scenic quality and facilitate pedestrian circulation. Lastly, a scenic shelter could be constructed.

2.5 JAMAICA POND

In 1990, the waters of Jamaica Pond met the standards of Class B water quality criteria (Metcalf & Eddy, 1990). In that the pond has relatively few

Historic View of Jamaica Pond

water quality problems and only minor sedimentation problems, project elements specific to Jamaica Pond will focus on landscape and architectural restoration (Figure 5).

2.5.1 Play Field Area

The ballfield should be reoriented to reduce impacts on the landscape.

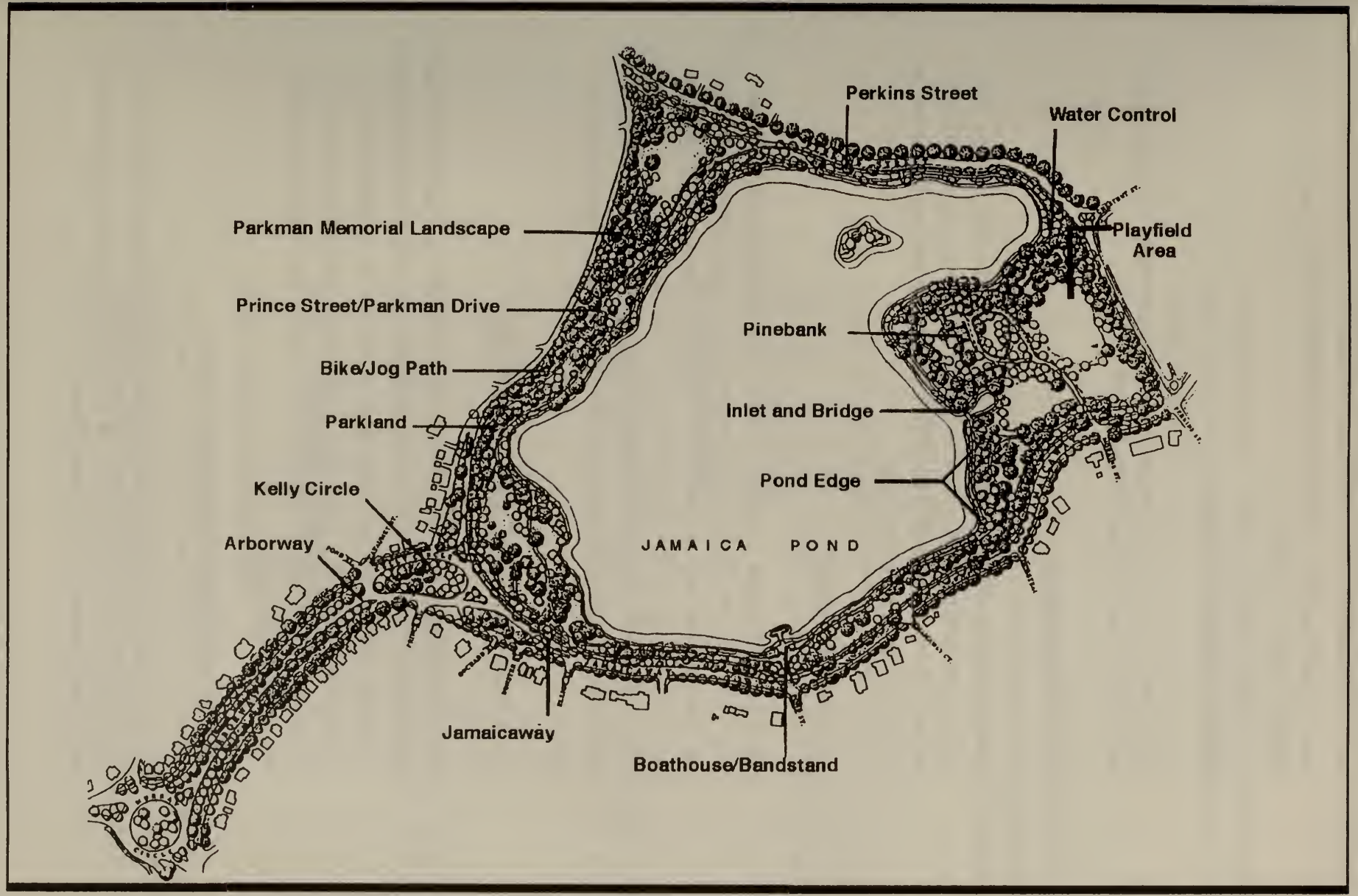
2.5.2 Perkins Street

Perkins Street could be reconfigured to regain space for dual pedestrian and bicycle path system.

Best Management Practices (BMP's) proposed for the Perkins Street area should include the installation of a silt separator, raising curbs and improving drainage structures.

2.5.3 Pinebank

Infrastructure improvements geared towards park visitors will include the rehabilitation of the stairs leading up to Pinebank, the recreation of one



Jamaica Pond Master Plan

SOURCE: Walmsley/Pressley (1986)

scenic shelter, and the control of vehicular access which should provide for the safe access for pedestrians.

2.5.4 Inlet and Bridge

The historic Jamaica Pond inlet could be reestablished by building a pedestrian bridge as was originally planned.

2.5.5 Pond Edge

Where necessary, eroded pond edges will be stabilized with rip-rap. This work is expected to be completed in 1999. Furthermore, a few trees that overhang for scenic effect will be retained and berry-bearing shrubs will be planted for increased wildlife value.

2.5.6 Jamaicaway

Along the Jamaicaway, plantings should be established along the urban edge (formal plantings) and at the park edge (informal planting) through the use of ornamental shrubs, trees, and herbaceous plants. Additionally, improvements should be made to the surface drainage system by increasing curb settings, and implementing Best Management Practices (BMP's). Finally, historic light fixtures could be introduced along the Parkway by the MDC.

2.5.7 Parkman Memorial Landscape

Within the vicinity of the Parkman Memorial, invasive plant species should be removed and the scenic views to the Memorial restored. The rehabilitation of the meadow adjacent to the Memorial could involve the establishment of native grasses and forbs. Access to the Memorial itself will be enhanced through the construction of new walkways. Lastly, the Memorial should be cleaned and re-pointed.

2.5.8 Prince Street/Parkman Drive

The MDC should reconfigure Prince Street/Parkman Drive to allow for the construction of a bicycle path and the visual and actual connection between the Parkman Memorial and Jamaica Pond.

2.5.9 Bicycle Path

A bicycle path will be created along the western perimeter loop around the pond. The enhancement of the path should encourage and facilitate recreational use within this area.

2.5.10 Park Land

Invasive vegetation throughout the park should be removed in order to restore the scenic effect. At the edge of the park, new plants will be introduced to increase plant species diversity and enhance wildlife habitat.

2.5.11 Kelley Circle

The intersection should be reconfigured to add land to the park and improve vehicular circulation to the Arnold Arboretum. The reconfiguration process will also involve landscape improvements and should regain the historic character of the traffic islands.

2.5.12 Arborway

Improvements should be made to the pedestrian crosswalk connections to the Arnold Arboretum. Additionally, formal parkway plantings could be strengthened.

2.5.13 Watershed

Improvements should be made to the surface drainage system by increasing curb settings, and implementing Best Management Practices (BMP's).

2.6 ARNOLD ARBORETUM

2.6.1 Bussey Brook CSO

The Bussey Brook CSO has discharged sewage into the Bussey Brook during times of peak stormflow. Massachusetts Water Resources Authority (MWRA) Projects specific to the Bussey Brook will involve correcting this problem.

2.6.2 Peters Hill Drainage Residential Flooding

Inadequate infrastructure within the Peters Hill area has induced the flooding of private residences. The Boston Water & Sewer Commission (BWSC) plans projects to correct these problems.

2.7 FRANKLIN PARK

2.7.1 Scarboro Pond

Improvements should be made to Scarboro Pond through dredging and wetlands restoration. Furthermore, BMP's should be implemented to control nutrient and sediment loading from the golf course.

2.7.1.1 Access Improvements

In order to facilitate the passage of pedestrians and golf carts within the Franklin Park area, it is proposed that a pedestrian/golf cart bridge be constructed over Scarboro Pond.

2.7.1.2 Pond Restoration

Scarboro Pond Inlet

The restoration of Scarboro Pond will involve the implementation of BMP's, dredging, and the planting of restorative wetland plantings.

2.7.2 Abbottspool

Restoration of the Abbottspool original basin footprint can be achieved through standard excavating practices and should be replanted with approved and historically appropriate wetland plantings. Best Management Practices will be implemented.

3.0 PROJECT PHASING

3.1 INTRODUCTION

Each of the improvements discussed in this report can be classed using a coarser scale which includes dredging, infrastructure improvements/BMP's, wetlands restoration/bank stabilization, and landscape improvements. The project elements are proposed to be organized in the following sequence:

(1) Dredging
(2) Infrastructure Improvements/BMP's
(3) Wetlands Restoration/Bank Stabilization
(4) Landscape Improvements

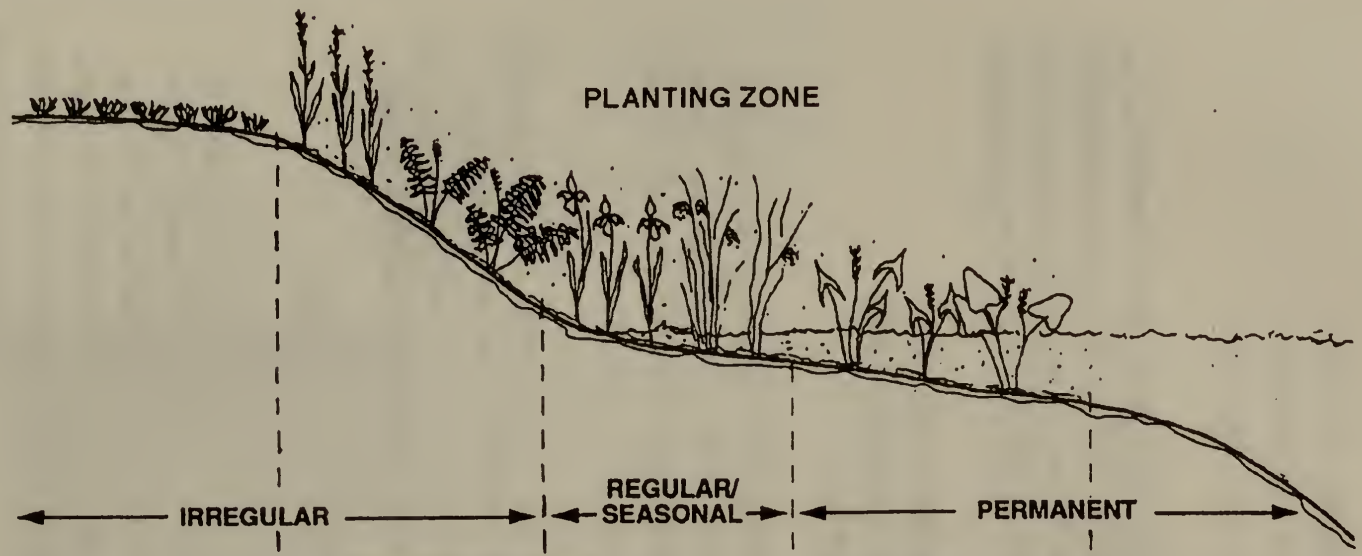
It is proposed that the dredged channel and associated water bodies be planted in accordance with an approved wetlands restoration plan similar to that presented in Figure 6. This planting plan will, of course, have to accommodate site-specific conditions.

Lastly, all landscape improvements, e.g. lawn plantings, specimen tree and shrub plantings, improvements to buildings/light fixtures etc., should be performed after all heavy machinery has been removed from the site(s) and will serve to offset any resultant damage during the construction process.

3.2 MUDDY RIVER SYSTEM DREDGING

It is proposed that the dredging of the Muddy River system be phased in order to provide an opportunity to actively minimize water quality impacts such as the resuspension of solids before the water reaches the Charles River. The phasing would first include the completion of the Boston Water and Sewer Commission cleaning of the conduits between Ipswich Street and the Charles River. This area would provide a final location for the settling out of suspended solids.

The next phase of dredging would be to dredge upstream of the Agassiz Bridge through the lagoon behind the Rose Garden. The purpose for this phase is to remove coarser and less problematic sediment and to provide opportunities to reduce turbidity by means of silt curtain deployment in the pools. The remainder of the dredging could then proceed in two parts: In the



PERIOD OF SATURATION

IRREGULAR — REGULAR/ SEASONAL — PERMANENT

PLANT SPECIES

- TURF
- SENSITIVE FERN *ONOCLEA SENSIBILIS*
- MARSH FERN *THELYPTERIS THELYPTEROIDES*
- CARDINAL FLOWER *LOBELIA CARDINALIA*
- WATER DOCK *RUMEX ORBICULATUS*
- SMARTWEED *POLYGONUM PERSICARIA*
- SOFT RUSH *JUNCUS EFFUSUS*
- BURREED *SPARGANIUM EURYCARPUM*
- BLUE FLAG IRIS *IRIS VERSICOLOR*
- WATER-PLANTAIN *ALISMA TRIVIALE*
- WATERWILLOW *DECODON VERTICILLATUS*
- MARSH MARIGOLD *CALTHA PALUSTRIS*
- PICKERELWEED *PONTEDERIA CORDATA*
- ARROWHEAD *SAGITTARIA LATIFOLIA*
- ARROW-ARUM *PELTANDRA VIRGINICA*

NOT TO SCALE

Muddy River Re-vegetation Schematic

SOURCE: CORTELL (1997)

area between Ipswich Street and the Agassiz Bridge (between the Victory Gardens, Mother's Rest, and the FEMA building), and the balance of the Back Bay Fens and the Riverway.

Because the sediments upstream of the rose Garden Lagoon have a higher organic content, suspended solids concentrations will be greater. Therefore, the provision of an extended settling basin at the lagoon and in front of the Boston gate houses will facilitate the settling of solids. For both short and long term planning, it is also proposed that the dredging also include over dredging at accessible locations. This will provide for settling basins that can be reached in the future for easier removal of settled solids before they can enter the river system.

The proposed dredging process will be phased as follows:

Muddy River System

(1) Charlesgate
(2) Back Bay Fens
(3) The Riverway
(4) Ward's Pond
(5) Willow Pond
(6) Leverett Pond

3.3 FRANKLIN PARK WATER RESOURCE IMPROVEMENTS

The dredging of the waterbodies within Franklin Park is proposed to begin within Scarboro Pond inlet while the restoration of Abbottspool will follow. Within Scarboro Pond, the resuspension of dredged bottom sediments and other dislodged debris will be controlled with the use of standard mitigation techniques, e.g. silt curtains, booms etc.

Franklin Park

(1) Scarboro Pond
(2) Abbottspool

4.0 PROJECT ENVIRONMENTAL PERMITTING/ REGULATORY COMPLIANCE/ MEPA STRATEGY

The following discussion sets forth a series of phases and tasks directed at the identification, evaluation, documentation, and permitting of proposed Emerald Necklace initiatives.

4.1 INITIAL REGULATORY SCREENING

Each of the anticipated federal, state, and local permits/approvals for all projects and alternatives have been identified and are discussed briefly in the following sections. As the program evolves, key regulatory authorities and agency personnel will be identified, as will the role each agency will play in the permitting of the individual projects.

4.1.1 Federal

The evaluation of the dredging of the Muddy River system and other projects that will impact wetlands at the federal level will involve conformance with rules and regulations stipulated within three federal-level permits:

Section 404(b)(1) of the Clean Water Act (33 U.S.C. 1344);

The US Army Corps of Engineers (ACOE) evaluates individual permit applications for the discharge of dredged or fill material under Section 404(b)(1) of the Clean Water Act (33 U.S.C. 1344) guidelines. These guidelines are the Federal environmental regulations for evaluating the filling of waters and wetlands and prohibit discharges:

- where less environmentally damaging, practicable alternatives exist;
- which result in violations of State or Federal Water Quality Standards, the Endangered Species Act, and the Marine Standards Act;
- which cause or contribute to significant degradation of waters and wetlands;
- if all appropriate and practical mitigation has not been taken; or
- if there is not sufficient information to determine compliance with the guidelines.

Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403); Section 10 authorizes the Corps to regulate certain structures or work in or affecting navigable waters of the United States.

National Pollution Discharge Elimination System (NPDES) Discharge Permit;

Assuming onsite dredged material dewatering and offsite disposal of contaminated sediments, this work must conform to the rules and regulations stipulated in a National Pollution Discharge Elimination System (NPDES) Discharge Permit issued by the Environmental Protection Agency. The dredged materials must be properly disposed of in a Massachusetts Department of Environmental Protection (DEP) approved, lined landfill.

Accordingly, conformance with these regulations protect federally identified wetlands functions and values (Table 1).

Table 1 Emerald Necklace Wetlands Functions and Values - Existing and Proposed

Functions/Values	Existing	Proposed
Groundwater recharge	P	P
Groundwater discharge	P	P
Flood storage and desynchronization	N/Y	P
Sediment/shoreline stabilization	Y	P
Nutrient removal/retention/transformation	N/Y	P
Nutrient export	Y	P
Aquatic diversity	N	P
Fish/shellfish habitat	N	Y
Wildlife habitat	Y	P
Endangered species habitat	Y	Y
Consumptive recreation	N	Y
Nonconsumptive recreation	Y	P
Uniqueness/heritage	P	P

(N = absence of function, Y = performance of function, P = principal valuable function).

Section 106 Review

Federal procedures governing the preservation of historic properties are incorporated in the environmental review process of the National Environ-

mental Policy Act (NEPA), the National Historic Preservation Act (NHPA), and Section 4(f) of the Department of Transportation Act.

The NHPA established the following mechanisms for the protection of historic resources under **Section 106 Review**:

- **The Advisory Council on Historic Preservation** is an independent government agency established to develop regulations and proce dures to enforce the terms of **Section 106.**

- In accordance with the *Review Process*, any federally licensed, funded, or otherwise assisted project is required, under **Section 106 of NHPA**, to be reviewed by the participating federal agency to deter mine the potential effect of the project on any National Register or National Register Eligible site.

4.1.2 State Statutory Interests

Anticipated state level permits will include demonstrated conformance with the rules and regulations specified in **Chapter 91 (314 CMR 9.00)**, Massachusetts Department of Environmental Protection regulations for Certification for Dredging, Dredged Material Disposal and Filling in Waters and will also require an individual **Section 401 Water Quality Certification** from the Department of Environmental Protection (DEP) . Furthermore, this project will have to demonstrate compliance with a **Determination of No Adverse Impact** by the Massachusetts Historical Commission.

The project will have to meet the performance standards specified in the **Massachusetts Wetlands Protection Act (310 CMR 10.00 *et seq.*)**. In that a bulk of the proposed work will be performed within and adjacent to a permanently flowing river, the interests expressed in the **Regulatory Revisions for the Rivers Protection Act Amendments to the Wetlands Protection Act** (1997) will also need to be addressed. The Massachusetts Rivers Protection Amendment provides for a Riverfront Area which, as it applies to the Muddy River, is defined as follows:

> *"...Riverfront areas within Municipalities...shall be defined as that area of land situated between a river's mean annual high water line and a parallel line located twenty-five feet away, measured outward horizontally, from the river's mean annual high water line"*

"Mean annual high-water line" is defined within the Massachusetts Rivers Protection Amendment to the Wetlands Protection Act as follows:

> *"...the line that is apparent from visible markings or changes in the character of soils or vegetation due to the prolonged presence of water and which distinguishes between predominantly aquatic and predominantly terrestrial land..."*

The following assessment of State-defined wetland statutory interests was conducted in accordance with the MA Wetlands Protection Act (MGL Chapter 131, Section 40) and associated regulations (310 CMR 10.00 *et seq.*). As stated in the regulations implementing the MA Wetlands Protection Act at 310 CMR 10.01(2), state listed statutory interests relative to wetlands include:

Protection of Public and Private Water Supply/Groundwater Supply: Resource areas presumed to be significant to the protection of public and private drinking water supplies, and to groundwater supply, include banks, bordering vegetated wetlands, and land under water bodies.

All of the resource areas within the project area act as interfaces between the surface and groundwater, where both discharge and recharge are likely to occur. Likewise, the vegetation, soils, and flat topography associated with bordering vegetated wetlands contribute to the protection of water quality by removing or detaining sediments, nutrients, and toxicants. Where land under water bodies contains organic deposits and fine sediments, these deposits and sediments may detain or remove nutrients and toxicants.

Flood Control/Storm Damage Prevention: Banks, bordering vegetated wetlands, land under water bodies, and bordering land subject to flooding are presumed to be significant to flood control and storm damage prevention. Banks and land under water bodies confine flood waters, and as such, contribute to the protection of adjacent and downstream lands from flood and storm damage. In general, both overland flow and bankfull discharge are attenuated as they pass through bordering vegetated wetlands, where the increased surface area of plant biomass obstructs flow and where relatively flat topography provides storage for flood waters. Most of the wetlands within the project area function in this capacity although it has been compromised somewhat by the accumulation of sediment.

Prevention of Pollution: As discussed earlier, the flat topography, plant

biomass, and soils associated with bordering vegetated wetlands contribute to the protection of water quality by removing or detaining sediments, nutrients, and toxicants. Where land under waterbodies contains organic deposits and fine sediments (most hemic-sapric mucks), these deposits and sediments may detain or remove nutrients and toxicants. The wetlands in the project area are presumed to function in this capacity.

Protection of Wildlife Habitat: Banks, bordering vegetated wetlands, land under water bodies, and bordering land subject to flooding are presumed to be significant to the protection of wildlife habitat.

The burrowing, feeding, and shelter opportunities afforded by banks constitute important wildlife habitat. Bordering vegetated wetlands and land under water bodies offer important wildlife food, shelter, migratory areas, overwintering and breeding areas. Factors contributing to these habitat-based features include hydrologic conditions, plant community composition and structure, soil composition and structure, topography, and water chemistry. In addition, bordering land subject to flooding which has not been significantly altered by human activity is significant to the protection of wildlife habitat. These areas include lands within the ten year floodplain, areas within 100 feet of the bank or bordering vegetated wetland and vernal pools. Such areas provide important food, shelter, migratory areas, overwintering areas, and breeding areas as a result of resource area topography, hydrologic conditions, vegetation, soils, and proximity to other resource areas.

Many of the areas within and/or adjacent to the Muddy River system can be presumed to be significant to the enhancement of wildlife habitat.

The dredging of the Muddy River system and the associated BMP's will improve the natural capacity of the aquatic biota by improving the ability of the wetland system to function in terms of flood control/storm damage prevention functions, and possibly fish and wildlife habitat. Fish and wildlife will be enhanced by restoring the pond as a permanent open water body. Permanent open water will provide required habitat for fish, other aquatic species, and waterfowl on a year round basis. Amphibians, reptiles, and mammals will also benefit from permanent open water conditions.

Conformance with Performance Standards - Bank: Section 310 CMR 10.54(1) of the MA Wetlands Protection Act regulations states that banks are presumed significant to: (1) protection of public or private water supply and

groundwater supply; (2) flood control and storm damage prevention; (3) prevention of pollution; and (4) protection of fisheries and wildlife habitat. In that it is not anticipated that either permanent or temporary fill will be placed on bank resources, it is anticipated that there will be temporary impacts to banks associated with access to the Muddy River system for dredging. These impacts will be mitigated through the use of sediment and erosion control devices (e.g. geotextile fabric fences and haybales). Upon the completion of the project, disturbed areas will be seeded and mulched, with all sediment and erosion control devices left in place until the slopes are revegetated.

Conformance with Performance Standards - Buffer Zone: Activities associated with the proposed project will occur within the State regulated buffer zone (100 ft. from banks or bordering vegetated wetland). However, such activities will be limited to equipment access to the dredging site, staging area activities, and dewatering/storage of dredged material. Haybales and or silt fences placed at the limits of disturbance prior to the commencement of dredging-related activities will preclude buffer zone activities from impacting adjacent resource areas. Upon project completion, disturbed areas will be seeded and mulched and all sediment and erosion control devices will be left in-situ until side slopes are naturally revegetated.

Conformance with Performance Standards - Bordering Vegetated Wetlands (BVW): Section 310 CMR 10.55(1) of the MA Wetlands Protection Act regulations states that bordering vegetated wetlands are presumed significant to: (1) protection of public or private water supply and ground water supply; (2) flood control and storm damage prevention; (3) prevention of pollution; and (4) protection of fisheries and wildlife habitat.

Mitigation during the construction process will consist of a geotextile fence and haybales. Upon project completion, disturbed areas will be stabilized with mulch and will be seeded. In that this is a wetlands restoration project there will be no net loss of BVW.

Conformance with Performance Standards - Land Under Water Bodies and Waterways: Section 310 CMR 10.56(1) of the MA Wetlands Protection Act regulations states that land under water bodies and waterways is presumed significant to: (1) protection of public or private water supply and groundwater supply; (2) flood control and storm damage prevention; (3) prevention of pollution; and (4) protection of fisheries and wildlife habitat.

Mitigation measures designed to limit temporary negative impacts have been incorporated into the dredging plan. Specific attention will be directed towards preventing sediments from traveling outside the area to be dredged. This could potentially entail placing haybales at the outlet of the each of the pond areas (i.e. Scarboro, Ward's, Willow, and Leverett Ponds). In addition, during dewatering operations, floating silt curtains could be placed within the pond downstream of the project area, if necessary. These silt curtains could remain in-situ during dredging activities to supplement haybale/geotextile fence controls, particularly during periods of high water.

Conformance with Performance Standards - Bordering Land Subject to Flooding: Section 310 CMR 10.57(1) of the MA Wetlands Protection Act regulations states that bordering land subject to flooding is presumed significant to: (1) flood control and storm damage prevention and (2) protection of wildlife habitat.

Impacts to bordering land subject to flooding will be limited to only those areas necessary for the easy access of the dredging equipment. Haybales and a geotextile fence will be placed at the limits of disturbance prior to the initiation of equipment access and dredging activities.

4.1.3 Local Regulatory Processes

This project will require the preparation of (1) a **Determination of Applicability (RDA)** for verification of wetland resource area boundaries, (2) submission of a **Notice of Intent (NOI)** for all activities subject to the MA Wetland Protection Act, and (3) issuance of an **Order of Conditions** in accordance with the Wetlands Protection bylaws as administered by the City of Boston Conservation Commission and the Town of Brookline Conservation Commission. Finally, the respective conservation commissions will have to review for **historic preservation**.

For each individual permit application, final design plans addressing both the proposed project and associated mitigation measures, to at least the 75% design level, are expected to be required for Commission consideration. A consolidated permit application containing all application forms and supporting documentation will be prepared for each project, thereby avoiding the redundant presentation of application materials. Draft permit applications will be provided to the project proponents for comment and review. Upon receipt of comments, the permit applications will be revised, accordingly, for filing

with appropriate regulatory agencies.

4.1.4 Endangered Species

The threespine stickleback (*Gasterosteus aculeatus*), which is a state listed threatened species (Massachusetts Natural Heritage & Endangered Species Program, 1998), occurs within one of the natural history pools which drains into Willow Pond. The natural history pools are small, permanently inundated, depressions, possibly of anthropogenic origin, and which are situated between Wards and Willow Pond (Olmsted Park).

Apparently, the loss of open water habitat within the pools may be contributing to a decline in the population size of the threespine stickleback. In addition, the spotted turtle (*Clemmys guttata*), which is a state listed special concern species, has been recorded within Leverett Pond (Massachusetts Natural Heritage & Endangered Species Program, 1995).

Before any work can begin within the vicinity of Natural History Pools (e.g. Ward's Pond, Willow Pond, and Leverett Pond), written notification of the scope of the project must be sent to the Massachusetts Natural Heritage and Endangered Species Program (MNESP). Their responses will dictate whether or not any work can be performed in this area, and if so, will indicate any special mitigation measures to be taken.

4.2 FORMULATION OF MEPA PERMITTING STRATEGY

Alternatives relative to MEPA Certification of the Emerald Necklace initiative (Figure 7) must be consistent with the new MEPA regulations (July, 1998). Section 11.09(4)(b) of the new MEPA regulations defines an Area-wide Review as follows:

> *"Area-wide Review. The Secretary may establish a Special Review Procedure where a project or Projects may affect a large area or several sites. As part of an Area-wide review, the Secretary may require an Area-wide ENF and periodic reports as well as other review documents. Examples include but are not limited to Master Plan areas, roadway and utility corridors, redevelopment areas, major*

public facilities, or large developments with phased implementation."

Section 11.09 of the new Massachusetts Environmental Policy Act (MEPA) (M.G.L. c 30 s.s. 61-62H) regulations defines a Special Review Procedure as follows:

" ...the Secretary may establish a Special Review Procedure for a Project, notwithstanding the other provisions of 301 CMR 11.00...a Special Review Procedure may provide for: review documents, shortened or extended review periods...lapses of time between review documents...coordination...of MEPA review with other environmental review...and permitting processes...and the establishment of a CAC..."

4.2.1 Preparation of ENF and Preliminary Draft EIR Scope for Area-Wide Review

The proponent initiates the MEPA review process with the preparation of an Environmental Notification Form (ENF), which includes a written description of the project and a preliminary indication of project impacts (Figure 7). Upon submission to the MEPA Unit, the Secretary will publish the ENF in the Environmental Monitor for public comment and review.

The request for a *Special Review Procedure* (SRP) will include an SRP model and a proposed ***Citizens Advisory Committee (CAC)*** constituency. The CAC ordinarily consists of at least ten persons appointed by the Secretary who shall assist in the review of the Project as it develops. In addition to the CAC, a ***CAC/public outreach and participation program*** will be developed.

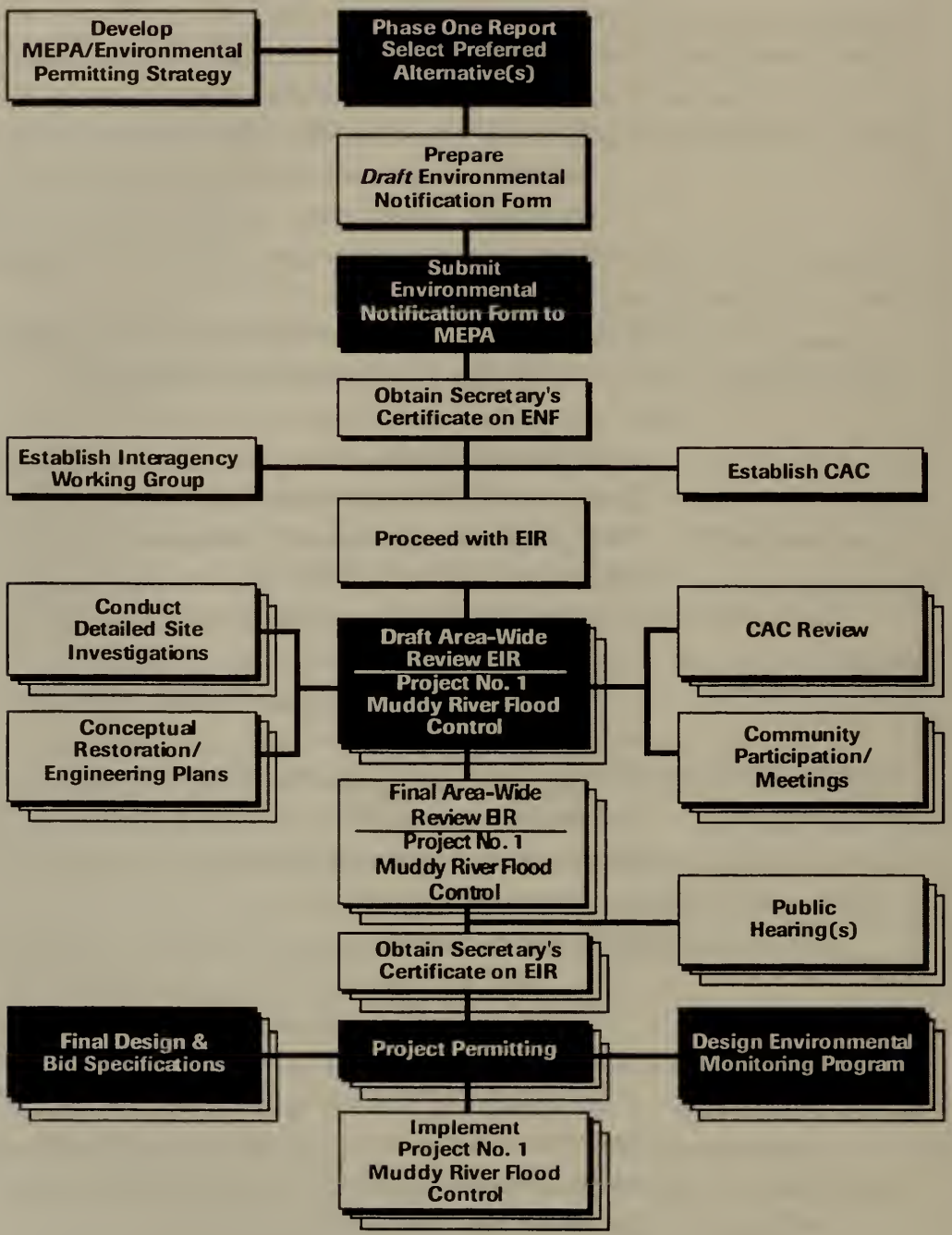
A conceptual Public Participation Plan (PPP) could include the following:

- Public Meetings (1-3 evening meetings)
- Regulatory Agencies and Conservation Group Meetings (1-3 daytime meetings)

The BPRD has conducted one site walk with the Boston Conservation Commission, The Brookline Conservation Commission, MEPA representatives (September 19, 1998), and has presented the Emerald Necklace Environmental Improvements Master Plan at a public meeting held at Simmons College, on September 22, 1998.

Following proponent review of the ENF, comments will be incorporated and

Figure 7 MEPA and Environmental Permitting Strategy



the final ENF prepared for filing with the MEPA Unit and agency/public distribution. As necessary, briefings of various public and private parties, relative to the contents and program intent of the ENF for the Emerald Necklace Initiative as presented, will be conducted.

4.2.2 EIR/Area-wide Review Scoping

This phase of the MEPA process involves discussions with the MEPA unit regarding the scoping of an Area-Wide review. Decisions by the Secretary regarding the preparation of either a Single EIR, or the more typical Draft and Final EIR, will be the anticipated outcome. Presentation graphics, handouts and similar materials will be prepared for these discussions, as well as for any public scoping session(s) conducted by the MEPA Unit.

4.2.3 Implementation of CAC/Public Outreach and Participation Program

Following the establishment of a Special Review Procedure (Area-wide Review), the CAC/public outreach and participation program will be implemented in accordance with the proposed program set forth in the ENF, as may be modified by the MEPA certificate on the ENF.

4.2.4 Preparation of Draft Area-Wide Review Documentation and Draft Section 61 Findings (Draft EIR)

Following MEPA scoping of the Area-wide Review and issuance of the Draft EIR Certificate by the EOEA Secretary, the proponent(s) will undertake and manage the detailed technical studies and analyses required to address the Draft EIR scope.

Such studies and analyses relative to projects included within the Emerald Necklace Environmental Improvements Master Plan will likely encompass, but not necessarily be limited to:

- Identification of all Federal, State, and local permits and approvals required for individual project implementation.
- Recreational facilities and opportunities
- Sediment characterization

- Surface water hydrology, aquatic biological resources and water quality
- Floodplains, flood control/management and flood hazard mitigation
- Vegetation and wildlife, including historic landscaping
- Wetlands
- Land use
- Stormwater management
- Historic, architectural, and cultural resources, and Section 4(f) lands

For each of the above issues, existing conditions, project-related impacts and mitigation measures will require documentation, as will the preferred design, it is anticipated that plans presented at the conceptual design level will be required for the Draft EIR to be deemed adequate by the EOEA Secretary. Additionally, the Draft EIR will categorize and respond to all written comments received on the ENF. A Draft Section 61 Findings addressing project alternatives, impacts, and proposed mitigation measures also will be prepared.

The Draft EIR will be distributed to Federal, State, and Local agencies, CAC members, and other interested individuals/stakeholders. If, and as necessary, various public and private parties will be briefed on the Draft EIR, including public meetings conducted by the MEPA unit.

4.2.5 Preparation of the Final Area-wide Review Documentation (Final EIR) and Draft Section 61 Findings

Following the Draft EIR review and issuance of the Draft EIR Certificate by the Secretary, any remaining and necessary technical studies and analyses required to address the Final EIR scope and document preparation will be conducted. At this point in the environmental review process, preliminary (25%) design plans are anticipated to be required for inclusion in the Final EIR.

Similar to the Draft EIR, the Final Area-wide Review (Final EIR) will be prepared using clear, concise narrative and graphics to provide a comprehensive and responsive assessment of the Emerald Necklace Environmental Improvements Master Plan. Additionally, the Final EIR will categorize and respond to all written comments received on the draft EIR. Working closely

with key permit authorities, draft Section 61 findings addressing project alternatives, impacts and proposed mitigation measures will be revised based upon Draft EIR comments and any project-specific refinements will be made prior to issuing the Final EIR.

5.0 ALTERNATIVES ANALYSIS

5.1 OVERVIEW

A large body of information predicated upon water quality data, sediment conditions, computer modeling, watershed characteristics, and numerous studies on the Muddy River system has been synthesized by the ACOE in a (1998) study. The study identified five basic alternatives to improve water quality within the Muddy River. The ACOE identified alternatives include the following:

- Flow Augmentation
- Off- Stream Treatment
- Aeration (in-stream treatment)
- Dredging (sediment removal)
- Upstream Source Control

The following discussion identifies some of the more salient features and obvious limitations of each alternative.

5.1.1 Flow Augmentation

Water quality modeling conducted by the ACOE (1998) indicated that by introducing aerated flow into the Muddy River, dissolved oxygen levels would be elevated to levels sufficient to maintain a Class B warmwater fishery. Of the two alternatives identified, directing water from the Charles River through the Muddy River Conduit was more acceptable than the introduction of low quality water from the Stony Brook.

The greatest drawback to this alternative is that flow augmentation would do little to control the growth of the giant reed *(Phragmites australis)*, decrease sedimentation, or improve the hydraulic capacity of the Muddy River system.

5.1.2 Off-Stream Treatment

The ACOE (1998) report evaluated two options concerning off-stream treatment and which would involve (1) the partial removal of pollutants (e.g. TSS, organics, nutrients) and (2) an increase in dissolved oxygen levels without

any pollutant removal.

Off-stream treatments are not acceptable due to the fact that they would require the construction of intrusive, historically insensitive structures that would be very costly to operate. Furthermore the effectiveness of these systems would be somewhat limited under extreme conditions (e.g. low flow, severe weather).

5.1.3 Aeration (in-stream)

Perhaps the greatest drawback to the in-stream aeration of the Muddy River is the fact that the elevated dissolved oxygen levels would be extremely localized. In order for the effects of this alternative to have system-wide impacts, a series of in-stream aeration systems would have to be implemented throughout the Muddy River system. Other additional factors that could possibly limit the efficacy of the localized elevation of dissolved oxygen levels would be biochemical oxygen demand (BOD), sediment oxygen demand (SOD), water temperature, water pH, etc.

Finally, in that low dissolved oxygen levels are but one part of a larger problem concerning water quality within the Muddy River system, it remains unclear as to whether or not an in-stream aeration system would help control the levels of other pollutants.

5.1.4 Dredging of Bottom Sediments

In their assessment of the dredging of the Muddy River System, the Corps identified seven levels of dredging (ACOE, 1998):

(1) Remove *Phragmites* in the Riverway.
(2) Remove *Phragmites* in the Back Bay Fens.
(3) Dredge the Riverway
(4) Dredge the Back Bay Fens
(5) Dredge Leverett Pond
(6) Dredge Leverett Pond and the Riverway
(7) Dredge the Entire River (Leverett Pond, the Riverway, and the Back Bay Fens.

Ultimately, the removal of all settled, high oxygen demand, organic matter through dredging would increase dissolved oxygen levels above 5 mg/l

(ACOE, 1998). Furthermore, the removal of contaminants and other sources of toxicity would result in a higher fish and invertebrate diversity, reduced odor levels, and improved aesthetics (ACOE, 1998).

The Corps study concludes that the dredging of the Muddy River would do little to impose long-term control on the quality of the water within the system without upstream source controls and that the benefits of the increased dissolved oxygen levels would be dredged area-specific. Subsequently, dredging was not the preferred alternative for the Corps of Engineers.

While it is true that increased dissolved oxygen levels would be dredged-area specific, and in instances of partial dredging may provide only limited benefits over the long term, the *complete* dredging of the Muddy River, in conjunction with upstream source controls and BMP's, should be able to maintain long term water quality control.

5.1.5 Upstream Source Control

Upstream source controls include those measures that ultimately treat stormwater flow before it enters the Muddy River system. The two upstream source controls discussed within the Corps report included swirl type degritters and media sand filtration units (ACOE, 1996) which are both considered structural controls (Kent, 1995).

Although these systems are somewhat expensive to install and maintain, they are highly recommended because they ultimately may be the most effective means of controlling the sediment load of stormwater discharge into the Muddy River.

On a smaller scale than the upstream source controls, it is suggested that BMP's be implemented such that they will effectively reduce stormwater pollution before it is washed off the streets and into the Muddy River system. While they are typically not effective on their own, using BMP's in conjunction with the proposed dredging should be quite effective.

5.2 DREDGING OF BOTTOM SEDIMENTS (Phase 1 Preferred Alternative)

The dredging of the Muddy River system and the disposal/ transportation of the excavated material to a Massachusetts Department of Environmental Protection (DEP) approved lined landfill is anticipated to be quite costly. However, dredging is considered to be an effective way to restore hydraulic capacity and improve water quality (Metcalf & Eddy, September-1990; Fenway Alliance, 1997).

Furthermore, dredging is the most positive control of both invasive emergents (giant reed) due to the physical removal of all significant portions of the plant as well as nutrient rich, soft bottom sediments and the control of submersed aquatic (fanwort) vegetation by excavating the channel/pond bottom to depths that correspond to the pre-industrial stream bed elevation.

There are, however, several limitations on the successful implementation of a dredging project and which include the following:

- The volume and chemistry of sediment which is to be dredged;
- The location and size of the laydown area(s)
- The construction necessary to prepare a laydown area (with supernatant water treatment) and;
- The length of time over which benefits derived from the dredging are expected.

The long-term effectiveness of dredging in controlling vegetation growth is subject to a constellation of factors. If a nutrient-poor bottom were to result from dredging (i.e. excavation to a mineral substratum with the consequent removal of the available seed bank), the control of the regrowth of both submersed and emergent macrophytes would be favorable.

The principal factors that determine the reestablishment of submersed macrophytes stem largely from life-history characteristics. For example, fanwort (*Cabomba caroliniana*) propagates vegetatively via a root system rather than from a seed source. Consequently, dredging would be fairly successful in the control of this species. In the instance of the giant reed (*Phragmites australis*), which propagates via rhizomes, removing the accumulated sediment and all significant plant components would severely limit the regrowth of this species.

The proposed project essentially involves three components, including approach/access, dredging activities, and dredged material removal/dewatering. It should be noted however, that dredged material would most likely be dewatered onsite prior to offsite disposal. Dredged material will be completely removed from the site and based on analytical results, disposed of in a DEP approved, lined landfill.

5.2.1 Dredging Alternatives

5.2.1.1 No Action

An alternative to the proposed dredging plan would be to take no action whatsoever. Under this alternative, no impacts to the resource area or buffer zones would occur and existing conditions would remain unaltered and may likely worsen. During periods of low flow, exposed sediments would likely dominate the Muddy River.

The Muddy River system does not, under existing conditions, meet Massachusetts water quality criteria for Class A waters with respect to fish and wildlife habitat, recreation, and aesthetics, and would continue to fail to meet such water quality criteria under the no action alternative. Specifically, if dredging is not undertaken, flood control, storm damage prevention and wildlife/fisheries habitat would not improve.

5.2.1.2 Partial Dredging

The ACOE (1998) study explored the possibility of dredging (1) Leverett Pond and The Riverway (51,788 cu.yds.) or just dredging (2) The Riverway (~ 30,000 cu.yds.).

Conducting a partial dredging of the Muddy River system, while perhaps improving wildlife habitat slightly, would ultimately constitute an expensive means to an incomplete solution of the flooding problems within the Muddy River system.

Woodward-Clyde, in their April 29, 1998 Engineering report on the flood control issue within the Fens, state that the dredging of a single channel within the Lower Fens alone should be the basis of a flood mitigation strategy. Their strategy involved the dredging of a 30 foot wide, 3,300 foot long channel, and which would measure several feet in depth. According to Woodward

Clyde (1998), this channel would improve flow conditions in the Lower Fens.

While it is true that the proposed channel, by increasing the hydraulic capacity of the Muddy River within the Fens, would improve flow conditions within the lower Fens during storm events, it would do little to correct flow restrictions further upstream during these storm events, and would not enhance flow during normal flow conditions.

Finally, it may be possible to conduct **selective dredging**, whereby selected portions of the Muddy River system are dredged, leaving small patches of desirable wetlands vegetation (i.e. northern arrowwood (*Viburnum recognitum*), winterberry (*Ilex verticillata*). This would entail the dredging of a central channel within portions of the Muddy River system and leaving the banks undisturbed.

The selective dredging of the Muddy River system is also undesirable for the same reasons cited for partial dredging, namely that selective dredging would do little to enhance flood control or control the spread of the giant reed (*Phragmites australis*).

Although the ultimate goal of the dredging process is to restore flood control, this project is also considered a wetlands restoration project. Subsequently, in a bank to bank dredging process, the newly dredged banks and shallows will be replanted with non-invasive wetland grasses, rushes, herbs, shrubs, and trees, whether they are transplanted from areas to be disturbed or come from pre-approved nursery stock. Although a seemingly drastic measure, the ultimate consequences of bank to bank dredging are far more positive than preserving an ailing wetland system.

5.2.1.3 Proposed Action

In the Muddy River Restoration and Action Plan prepared and submitted by the Fenway Alliance (1997), it is suggested that a complete, bank to bank dredging of the Muddy River System (i.e. from Ward's Pond to the Charles River) should be conducted. The Fenway Alliance (1997) conclude that the removal of all accumulated sediment and invasive vegetation should constitute an important first step in improving the water quality of the Muddy River system. This Phase I report also supports this approach to the dredging process within the Muddy River system.

The total amount of accumulated sediment that is proposed to be removed from the Muddy River system has been estimated to equal 172,000 cu.yds., and which includes the complete removal of stands of the giant reed *(Phragmites australis*). The primary project activity (dredging) will involve the removal of accumulated sediment (volumes are approximate) from the following areas:

Muddy River System

• Ward's Pond	19,340 cu.yds.
• Willow Pond	9,670 cu.yds.
• Riverway	30,000 cu.yds.
• Leverett Pond	21,788 cu.yds.
• Back Bay Fens	91,102 cu.yds

The proposed plans to dredge the Muddy River system will impact land under water, banks, bordering vegetated wetlands, bordering land subject to flood ing, and buffer zones. However, these impacts would be temporary and limited primarily to the period of dredging. Ultimately, the implementation of the proposed plan will improve the functioning of the Muddy River system in terms of hydraulic capacity, water quality, storm damage prevention, and fish/ wildlife habitat.

Franklin Park

• Scarboro Pond	5,000 cu.yds.
• Abbottspool	83,809 cu.yds.

5.2.2 Dredged Sediment Characterization

In that much of the bed material proposed to be dredged from the Muddy River is contaminated, the following section contains the analytical data of the river bottom sediments that was conducted by the ACOE (1996) and the USGS (1997). These data are presented to indicate the most recently determined levels of hazardous compounds and the extent of the contamination of sediments within the Muddy River system and are used for illustrative purposes only.

In that a proper dredging protocol must include current and site-specific sampling and analysis of sediments to be dredged, methods for dredged material treatment and disposal as proposed within this report will not be predicated upon the following information. All proposed dredging plans will

be accompanied by supplemental sediment characterization that goes beyond the following information.

In an effort to characterize the bottom sediments within the Muddy River system, seven (7) sediment core samples (designated 96-1 - 96-7) were collected by the United States Army Corps of Engineers (ACOE, 1996) on April 12, 1996 along the Emerald Necklace in Brookline and Boston, Massachusetts (Table 2).

Total petroleum hydrocarbons (TPH) in excess of the current Massachusetts Department of Environmental Protection (DEP) Lined Landfill Reuse Allowable Contamination Levels for Soil Criteria (DEP Policy COMM-97-001; August 15, 1997) were detected at sample locations 96-1, 96-2, 96-4, 96-5, 96-6 and 96-7 at depths ranging from 20" (96-7) to 60" (96-6) below the streambed. Sediment analytical results from sample locations 96-6 and 96-7 also indicated levels of polychlorinated biphenyls (PCB's) in excess of the Lined Landfill Reuse Criteria as well as hazardous levels of lead using the Characteristic Leachate Procedure (TCLP). Unlined Landfill Reuse Criteria (DEP Policy COMM-97-001; August 15, 1997) was exceeded for TPH levels detected at sample location 96-3.

Table 2 **Sediment Core Sample Characterization** (ACOE, 1996).

Sample I.D.	Location	Parameter(s) in Excess of DEP Lined/Unlined Landfill Reuse Criteria	Approximate Depth of Contamination
96-1	Southern portion of Leverett Pond; approx. 400' north of the Daisy Field Drain	Lined - TPH	42"
96-2	Eastern side of the central portion of Leverett Pond	Lined - TPH	48"
96-3	Northern portion of Leverett Pond adjacent to the Village Brook Drain	Unlined - TPH	50"
96-4	Muddy River; approx. 800' north of the Tannery Brook Drain *(within Phragmites)*	Lined - TPH	40"

96-5	Muddy River (northern portion); approx. 500' southwest of the intersection of the Riverway & Park Drive	Lined - TPH	24"
96-6	Back Bay Fens; adjacent and downstream of Boston Gatehouses #1 & #2	Lined - PCBs, TPH *Haz. Waste - Pb*	60"
96-7	Back Bay Fens; approx. 400' north of the Agassiz Bridge *within Phragmites)*	Lined - PCBs, TPH *Haz. Waste - Pb*	20"

PCBs - polychlorinated biphenyls, **Pb** - lead, **TPH** - total petroleum hydrocarbons,
Haz. Waste - Pb - Levels of lead in excess of federal hazardous waste criteria using the Toxicity Characteristic Leaching Procedure.

Sediment core samples were collected by the United States Geological Survey (USGS, 1997) on October 30-31, 1997 at fifteen (15) stations (designated Station No. 1 - 15) along the Emerald Necklace in Brookline and Boston, Massachusetts (Table 3).

Excluding Station No. 8, each sample location exceeded the current DEP Lined Landfill Reuse Criteria for TPH. However, Station No. 8 sediment sampling analytical results indicated elevated levels of polyaromatic hydrocarbons (PAHs) in excess of the Lined Landfill Reuse Criteria. Lined Landfill Reuse Criteria for PAHs were also exceeded at Station Nos. 1-4, 9, and 11-15. Total arsenic levels exceeded Lined Landfill Reuse Criteria at Station Nos. 2, 7, 9 and 10. PCBs concentrations in excess of the Lined Landfill Reuse Criteria were detected at Station Nos. 9, and 11-15.

The most recent analytical data (*USGS Report 98-4027*; 1998) indicated that sediment located within the Emerald Necklace, specifically from Leverett Pond to the northern end of the Back Bay Fens, should be dredged to a mean depth of approximately 2.5-3.0 feet below the streambed or at least to the interface of observed fill material or pre-industrial streambed sediment at certain locations along the Riverway.

Previous sampling investigations have indicated that sediments to be excavated from the Riverway were in excess of the current Massachusetts Department of Environmental Protection (DEP) Lined Landfill Reuse Allowable Contamination Levels for Soil Criteria (DEP Policy COMM-97-001; August 15,

1997) and therefore cannot be disposed of at such facility. Analytical results presented in the July 1996 ACOE report indicated hazardous levels of lead at two locations (96-6 and 96-7) within the Back Bay Fens. Sediment excavated from this area should be disposed of at a regulated hazardous waste disposal.

Table 3 Sediment Sample Core Characterization (U.S.G.S., 1997).

Station No.	Location	Parameter(s) in Excess of DEP Lined Landfill Reuse Criteria	Approximate Depth of Contamination
1	Southern portion of Leverett Pond	PAHs, TPH	2.5'
2	Central portion of Leverett Pond	As, PAHs, TPH	2.5'
3	Muddy River; approx. 480' northeast of the Tannery Brook Drain	PAHs, TPH	2.5'
4	Muddy River; approx. 220' northeast of the Longwood Avenue Drain	TPH, PAHs	2'
5	Muddy River; approx. 100' north-northeast of the Longwood Avenue Bridge	TPH	1.5'
6	Muddy River; approx. 220' northeast of the Muddy River Footbridge	TPH	3'
7	Adjacent and prior to the Brookline Gatehouse	As, PAHs, TPH	0.5'
8	Upper Fens; between Brookline Avenue Gatehouse and the Emmanuel College Drain (Overflow)	PAHs	2.5'
9	Back Bay Fens; approx. 220' southeast of the Fen Bridge	As, PCBs, PAHs, TPH	1.5'
10	Back Bay Fens; southwestern side of lagoon area and approx. 80' east-northeast of western footbridge	As, TPH	1.5'
11	Back Bay Fens; approx. 90' north of Stony Brook Overflow (Boston Gatehouse No. 1)	PCBs, PAHs, TPH	6.5'
12	Back Bay Fens; approx. 40' south of the Agassiz Bridge	PCBs, PAHs, TPH	6.5'

13	Back Bay Fens; approx. 340' east-northeast of the Agassiz Bridge	PCBs, PAHs, TPH	2.5'
14	Back Bay Fens; approx. 600' south of the Boylston Street Bridge	PCBs, PAHs, TPH	0.5'
15	Back Bay Fens; approx. 160' south of the Boylston Street Bridge	PCBs, PAHs, TPH	3'

As - arsenic, **PCBs** - polychlorinated biphenyls **PAHs** - polyaromatic hydrocarbon **TPH** - total petroleum hydrocarbons

6.0 ESTIMATED COSTS

The following list of costs is based upon dredge volume data and bank impact determinations obtained from CDM Inc. (1998), EOEA (1998), the USGS (1997), and CORTELL (1998) calculations. All sub-totals have been rounded. More specifically, dredge volumes within sections 6.1.2, 6.1.3 and 6.1.4 are based upon the USGS (1997) estimates, while bank impacts are provided by CORTELL (1998). Within sections 6.1.5 and 6.1.6 both dredge volumes and bank impacts are provided by CORTELL (1998). Estimated costs for recommended source controls will be provided during Phase I of the MEPA
permitting process.

6.1 MUDDY RIVER SYSTEM

6.1.1 Charlesgate/Ipswich Street to Charles River

Sub-Total	**$ 2,500,000**

6.1.2 Back Bay Fens

Dredging/Dewatering (lime stabilization) 91,102 cu. yds. @ $30/cu.yd	$ 2,733,060
Trucking/Landfilling @ $80/cu.yd. 84,321 cu.yds. (USGS)	$ 6,745,680
Dredge/Dewater 6,700 cu.yds.TCLP sediment @ $254/cu.yd.	$ 1,701,800
Foundation Investigation	$ 18,533
Bank Stabilization/Restoration 23,200 lf @ $35/lf	$ 812,000
Daylight Upper Fen's Pond to Back Bay Fens	$ 2,000,000
Daylight Riverway to Brookline Ave.	$ 2,658,220
Upgrade Brookline Ave. to Upper Fen's Pond	$ 2,000,000
Modify Brookline Ave. Gate House	$ 497,874
Sub-Total	**$ 19,000,000**

6.1.3 Riverway/Sears Parking Lot to Route 9

Dredging/Dewatering (lime stabilization) 30,000 cu. yds. @ $30/cu.yd	$ 900,000
Trucking/Landfilling @ $80/cu.yd. 30,000 cu.yds. (USGS)	$ 2,400,000
Foundation Investigation	$ 6,185
Bank Stabilization/Restoration 7,883 lf @ $35/lf	$ 275,905
Sediment Weir at Tannery BrookOutfall	$ 70,000
Sub-Total	**$ 3,700,000**

6.1.4 Leverett Pond

Sediment Removal	
Dredging/Dewatering (lime stabilization) 21,788 @ $30/cu.yd.	$ 653,640
Trucking/Landfilling @ $80/cu.yd. 21,788 cu.yds.	$1,743,040
Bank Stabilization 5,517 lf @ $35/lf	$ 193,095
Sediment Weir at Village Brook Drain	$ 70,000
Sub-Total	**$2,700,000**

6.1.5 Willow Pond

Sediment Removal (1 acre x 6' dredge depth = 9,670 cu. yds.)	
Dredging/Dewatering (lime stabilization) 9,670 cu.yds.@ $30/cu.yd.	$ 290,100
Trucking/Landfilling 9,670 cu.yds.@ $80/cu.yd.	$ 773,600
Bank Stabilization 700 lf @ $35/lf	$ 24,500
Sub-Total	**$ 1,000,000**

6.1.6 Ward's Pond

Sediment Removal (3 acres @ 4' dredge depth = 19,340 cu. yd.	
Dredging/Dewatering (lime stabilization) 19,340 @ $30/cu.yd.	$ 580, 200
Trucking/Landfilling @ $80/cu.yd.	$1,547,200
Bank Stabilization 1,500 lf @ $35/lf	$ 52,500
Sub-Total	**$2,200,000**

6.1.7 Project Management/Permits/Engineering

Design Contingency (20%), Permit Acquisition & Engineering (10%)	$ 4,418,352
Sub-Total	**$ 4,418,352**

MUDDY RIVER CONSTRUCTION TOTAL $40,400,000

6.1.8 General Conditions (Project Wide)

General Conditions	$ 2,800,000
Sub-Total	$ 2,800,000

MUDDY RIVER TOTAL $43,200,000

6.2 FRANKLIN PARK

6.2.1 Scarboro Pond

Sediment Removal	
Dredging/Dewatering (lime stabilization) @ $30/cu.yd. Trucking/Landfilling @ $80/cu.yd 7.1 acres @ 6' dredge depth = 5,000cu.yd. T@ $110/cu.yd.	$ 550,000
Sub-total	**$550,000**

6.2.2 Abbottspool (Optional)

Sediment Removal	
Dredging/Dewatering (lime stabilization) @ $30/cu.yd. Trucking/Landfilling @ $80/cu.yd 6.5 acres @ 8 dredge depth = 83,809cu.yd. T@ $110/cu.yd.	$ 9,219,038
Sub-total	**$9,219,038**

6.2.3 Permits/Engineering

Permit Acquisition	$250,000
Engineering	$1,451,855
Sub-Total	**$1,701,855**
TOTAL	**$11,470,893**

7.0 REFERENCES CITED

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Soil Conservation Service (SCS) (October, 1992). Soil Bioengineering for Upland Slope Protection and Erosion Reduction. Engineering Field Handbook, United States Department of Agriculture.

U.S.G.S (1998). Draft Feasibility Report- Muddy River Feasibility Study- Boston and Brookline, Massachusetts. USGS Report, February, 1998

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Attachment A

Prior Studies and Reports (1966-1998)

Prior Studies and Reports 1996-1998

A significant body of information concerning the Muddy River water quality, sedimentation rates, and methods to correct these problems, has been generated over the past 32 years. A catalog of these studies is presented below with those studies reviewed by CORTELL including a brief abstract:

- Chief of Engineers (April, 1966). Reconnaissance Report-Local Protection, Muddy River, Boston-Brookline, Massachusetts

- ACOE (May, 1968). Charles River Interim Report-Lower Charles River.

- ACOE (1972). Charles River Study Report.

- C.E. Maguire (May, 1973). Water Quality Improvement.

- C.E. Maguire (July, 1976). Dredging and Degritting Research and Demonstration Project in the Boston Back Bay Fens.

Prepared for the Massachusetts Division of Water Pollution Control, the report comprised a research and demonstration project involving the evaluation of the aesthetic and ecological effects of equipment and methods used for dredging and degritting sludge and deposits accumulated on the floor of the Back Bay Fens Pond system. Dredging was conducted utilizing a floating hydraulic dredge and sludge pump system, distribution pipeline, coarse screening (inclined bar-rack), washer-classifier (single ribbon screw-type), cyclonic degritting and final grit disposal equipment. A total of approximately 10,000 cubic yards of sediment was removed from the Back Bay Fens Pond system, primarily in the vicinity of the Boston Gatehouses. Results of the study indicated that the dredging and degritting system demonstrated could be utilized without adverse effects to the local environment.

- Massachusetts Division of Water Pollution Control (November, 1976). The Charles Basin Water Quality Survey Data - 1974.

- Carol Johnson & Associates, Inc. (January, 1977). Back Bay Fens Preservation Master Plan.

- C.E. Maguire, Inc. (February, 1977). Flow Augmentation of the Boston Back Bay Fens Pond.

- Zaitzevsky, Cynthia (1982). Frederick Law Olmsted and the Boston Park System. The Belknap Press of Harvard University Press, Cambridge, Massachusetts and London, England.

- Metcalf & Eddy (December, 1984). Boston Gatehouses Section 106 Review.

- Baystate Environmental (1986). Preliminary Evaluation of Scarboro Pond & Abbottspool.

- Massachusetts Division of Water Pollution Control (February, 1987). Muddy River-Back Bay Fens, 1986 Water Quality Data and Water Quality Analysis.

- Whitman Howard, inc. (December 29, 1988). Combined Sewer Overflow Facilities Plan, Technical Memorandum B3-1

- Metcalf & Eddy (December, 1989). Boston Gatehouses Section 106 Review, Draft Case Study Report.

- The Halverson Company (1990). Franklin Park Master Plan.

- Walmsley/Pressley (1990). Emerald Necklace Master Plan

- Metcalf & Eddy (September 28, 1990) Muddy River Water Quality Improvement Plan

Funded and managed by the Massachusetts Executive Office of Environmental Affairs (EOEA) and the Massachusetts Department of Environmental Protection (MA DEP), respectively, the project entailed the review of previously documented surface water and sediment quality and the investigation of contributing/impacting Muddy Water watershed drainage and sewerage systems.

M&E field investigations indicated that 111 outlet pipes discharge to the Muddy River waterway including 94 drains generating directly from stormwater drainage systems. Other piping within the system include subsur-

face drains (7), water main blowoffs (3), connecting conduits (3), an abandoned pipe (1), combined sewer overflows (2) and a brook from Sargents Pond (1).

Water quality improvements recommended by M&E were separated into "high priority" (within 5 years) and "long term" (within 20 years). "High priority" water quality improvements included: the elimination of sewer cross-connections; stormwater pretreatment practices; eliminate the surcharging of the Francis Street Siphon; diverting Muddy River flow from the Diversion Conduit (discharging directly into the Charles River) to the Back Bay Fens; incorporating Best Management Practices (BMPs); and educating the public. "Long term" water quality improvements included: the reduction of combined sewer overflows to the Boston Gatehouses; Muddy River flow augmentation; dredging of sediments; and the removal of invasive vegetation (*Phragmites*).

- Metcalf & Eddy (September, 1992). Muddy River Water Quality Improvement Plan.

- Anderson-Nichols and Company, Inc. (October, 1992). Phase I Planning Report on Rehabilitation of the Muddy River Conduit.

- Blanc, F.C & Gregory, C.J. (November, 1992). Treatment of an Urban waterway as a Stormwater Mitigation Measure; A demonstration Pilot Treatment Project Proposal.

- ACOE (December, 1992). Reconnaissance Report, Water Resources Study, Muddy River Watershed; US Army Corps of Engineers (New England Division)

Funded by the United States Congress in the Energy and Water Development Appropriation Act for fiscal year 1992, this study was performed in order to review the water resource problems in the Muddy River watershed, develop and evaluate solutions, and determine if further Corps of Engineers involvement was justified. The report concluded that further involvement was deemed unnecessary based on the lack of economically justified flood damage reduction measures. The Corps additionally noted that principal damage areas within the Muddy River did not meet minimum flow criteria for Corps involvement at the time of their investigation.

- Metcalf & Eddy (June, 1994). Alternatives for CSO Control.

- Metcalf & Eddy (August, 1994). Baseline Water Quality Assessment, Master Planning, and CSO Facility Planning.

- Metcalf & Eddy (September, 1994). Draft CSO Conceptual Plan and System Master Plan, Volume One: Recommended Plan and Volume Two: CSO Strategies.

- Metcalf & Eddy (December, 1994).

- Blanc, F.C & Gregory, C.J. (June, 1995).

- U.S. EPA (July 26, 1995). Letter from USEPA Region I to US Army Corps of Engineers (New England Division); Re: Muddy River Sediment Oxygen Demand.

The letter reported the sampling and analysis of five (5) replicate sediment core samples at four locations (Leverett Pond, Park Drive/northeastern portion of the Muddy River, Museum Pond and Firehouse Pond) collected by the US EPA's Biology Section and analyzed for sediment oxygen demand (SOD). The letter stated that the elevated SOD rates ($\geq$22 gm O_2/m^2/day in Leverett Pond and $\geq$28 gm O_2/m^2/day along Park Drive) were some of the highest levels ever detected by the Section.

- CDM (November 10, 1995). Letter Report to US Army Corps of Engineers (New England Division) from CDM Federal Programs Corporation; Re: Muddy River Water Quality Investigation.

The purpose of the study was to develop a detailed base map of the Muddy River watershed and identify stormwater sampling locations that represent the watershed's major land use types. Water quality samples were obtained and analyzed from two sampling locations. CDM concluded that stormwater quality in Brookline was generally comparable to nationwide urban stormwater quality.

- Blanc, F.C & Gregory, C.J. (December, 1995). Modeling and Data Acquisition Project on the Muddy River Back Bay Fens System; Northeastern University - Department of Civil Engineering

The purpose of this study was to present results of field studies conducted during the summer of 1995 on the Muddy River and to produce quantitative

information concerning various processes related to bottom deposits, submerged aquatic plant life and plankton activity in order to provide data for mathematical water quality models for the waterways. This data was specifically used by the US Army Corps of Engineers (New England Division) in their July 1996 Draft Feasibility and July 1998 Revised Draft Feasibility reports for the Muddy River.

- U.S. ACOE (February, 1996). Muddy River Feasibility Study, Boston and Brookline, MA.

- U.S. ACOE (February, 1996). Muddy River Feasibility Study, Boston and Brookline, MA (Addendum April, 1996).

- City of Boston (April, 1996). Open Space Plan for Boston.

- Cortell Associates Inc. (April, 1996). Interim Vegetation Monitoring Report: Black Plastic Demonstration Areas.

- U.S. ACOE (July, 1996). Draft Muddy River Feasibility Study, Boston and Brookline, Massachusetts; US Army Corps of Engineers (New England Division); Revised July 1998.

The purpose of this study, as outlined in the Feasibility Cost Sharing Agreement with the Commonwealth of Massachusetts, was to identify the water quality and related environmental problems and needs of the Muddy River Basin. The study included a review of existing Muddy River investigations, onsite investigations, sediment and water quality data analysis, as well as computer water quality modeling analysis. The report concluded that water quality "is impacted primarily by the river's sluggish and stagnant flow regime, pollutant loads that enter the river from an extensive drainage system, and years of accumulated sediments."

The Corps indicated that: "Although correction of sewer cross connections, treatment of combined sewer overflows, additional source control, and other initiatives are expected to improve existing conditions, poor water and aquatic habitat problems are expected to persist. Since low dissolved oxygen levels have the greatest impact on water and habitat quality, increasing these levels to over 5.0 mg/l will be the primary consideration in developing improvement plans."

The study concluded that flow augmentation, via aeration, was "the logical first step in the overall improvement of the water and habitat quality of the Muddy River." The Corps considered that dredging contaminated sediments would provide a stopgap remedy since without effective source control measures, sediments would continue to enter the system. Therefore, the benefit of sediment removal would be short lived (7-10 years).

Major discrepancies of this report, as maintained in the revised version, include inconclusive field data collection, flawed critical assumptions and lack of historical and aesthetic conservation. For example, field data and accompanying analysis and interpretation which consisted of the monitoring of dissolved oxygen (DO) and sediment oxygen demand (SOD) by the US EPA Biology Section as well as Northeastern University during the summer of 1995, were inherently inconsistent. The US EPA Biology Section noted that "the SOD rates achieved during this study under typical analysis do not indicate the high degree of oxygen demand which these sediments are capable of once they are become resuspended in the water column. The sediments are so light and fluffy at each of these stations that they may be resuspended by the slightest disturbance such as swimming birds, wind, and certainly during the increased flow caused by rain events." The Corps, in their Water Quality Assessment section, indicate that there was difficulty in providing accurate measurements for DO and SOD due to the above referenced phenomena. The Corps continued further in the text to conclude: "Because of the stagnant nature of the Muddy River, most pollutants will settle out including organics, suspended solids, and heavy metals. Their effects are not evaluated through modeling since after settling, resuspension of solids would be minimal since a very large storm would be required (estimated at greater than a 10 year return frequency, approximately 400 cfs..."

The Corps report(s) does not provide consistency in reporting data, modeling critical assumptions and arriving at conclusions.

- U.S. ACOE (December, 1996). Muddy River Flood Analysis Storm of 20-21 October, 1996.

- BWSC & MWRA (December, 1996). Report on October 20-21, 1996 Storm; Boston Water & Sewer Commission (BWSC) and Massachusetts Water Resources Authority (MWRA); December 2, 1996

This report was prepared in response to a request by City of Boston Mayor

Thomas M. Menino and entailed a detailed description of the storm event, performance of MWRA sanitary and BWSC sanitary and stormwater sewer systems, analysis of two major flood areas, and the presentation of proposed corrective actions to be implemented prior to sufficiently control future extreme storm events.

- C.E. Maguire, Inc. (February, 1997). Flow Augmentation of the Boston Back Bay Fens Pond, Massachusetts Division of Water Pollution Control.

- Dufresne-Henry, Inc. (February, 1997). Independent Review of October 20-21 Storm, 1996 by BWSC & MWRA.

- Emerald Necklace Conservancy (March, 1997). Emerald Necklace Master Plan Volume II.

- Camp, Dresser, & McKee (August, 1997). Boston Water and Sewer Commission, Storm Brook Sewer System Study, Executive Summary.

- USGS (October, 1997). Channel Morphology and Streambed-Sediment Quality in the Muddy River, Boston and Brookline, Massachusetts; United States Geological Survey (USGS).

Citing that existing Emerald Necklace data was insufficient to make "informed regulatory decisions regarding the advisability of sediment removal from the Muddy River, and the optimal disposal or reuse options for the dredged sediments", the USGS conducted this study which entailed the determination of the Emerald Necklace system bathymetry and thickness of streambed sediment, volumes of streambed sediment, and occurrence and distribution of total trace metals and organic compounds.

The Emerald Necklace system was separated into three sections: Leverett Pond, the Riverway, and the Back Bay Fens for study purposes. System-wide bathymetry was determined to range from 0 meters in portions of Leverett Pond to 2.1 meters in the pool areas of the Back Bay Fens. The average water depth of the Riverway and the Back Bay Fens was reportedly 0.4 meters and less than 0.5 meters, respectively. The report indicated that many of the sedimentary structures in the Muddy River (including point bars and deltas), derived from more than 100 stormwater runoff drains over an

approximately 35 year period (roughly 11,500 cubic meters of sediment were reportedly removed from the Back Bay Fens in 1976 - U.S. Army Corps of Engineers, 1992), were colonized by the rapid expansion of invasive vegeta tion (i.e. giant reed (*Phragmites australis*)).

The USGS concluded that approximately 22,100, 17,500 and 69,600 cubic meters of sediment have accumulated in Leverett Pond, the Riverway and the Back Bay Fens, respectively. Based on the USGS's review of the 1992 U.S. Army Corps of Engineers Reconnaissance Study, Phragmites infesta tion was determined to occupy approximately 30% (8,000 square meters) and 70% (21,500 square meters) of the Riverway and the Back Bay Fens, respectively.

Fifteen soft sediment core samples were obtained from the Emerald Neck-lace system. Sediment samples were analyzed for total trace metals, trace metals using the Toxicity Characteristic Leaching Procedure (TCLP), orga-nochlorine pesticides, polychlorinated biphenyls (PCBs), polyaromatic hydro-carbons (PAHs), total petroleum hydrocarbons (TPH), total organic carbon (TOC), grain size distribution and percent moisture content. Analytical results exhibited excess levels of total trace metals, PAHs, TPH and PCBs.

Cortell has noted that excluding one sampling location (No. 8 - Upper Fens Pond), each sample location exceeded the current MA DEP Lined Landfill Reuse Criteria for TPH. The Upper Fens Pond sample exceeded similar criteria for PCBs.

- The Fenway Alliance (November, 1997). The Muddy River Restora-tion and Action Plan (DRAFT);

The Fenway Alliance formed a task force including its member institutions and planning consultants (Haley & Aldrich and Pressley Associates) to draft this restoration and preventive action plan. The study's goal was to provide an action and maintenance plan that would aid in restoring the Emerald Necklace river system to it's intended condition. Data for this Action Plan was compiled from over a decade of studies which included analyses of isolated storm events to full-scale master plans. This information was consolidated into this brief report in order to be widely distributed to the appropriate inter-ested parties including area residents, policy-makers and additional constitu-encies involved with the project.

The Alliance concluded that through careful planning and implementation of flood mitigation, river and park restoration, and maintenance activities (as provided through reviewed existing site studies), the Emerald Necklace inter-linked park system could be restored to its historic beauty and intended use.

- Camp, Dresser, & McKee (December, 1997). BSWC, Technical Memorandum Number 1, Preliminary Assessment of the Muddy River Capacity and Selection of Storm Events.

- U.S. ACOE (February, 1998). Draft Feasibility Report-Muddy River Feasibility Study, Boston and Brookline, Massachusetts; US Army Corps of Engineers (New England Division).

This report simply entailed the editing revisions to the July 1996 Draft Corps Study to be incorporated into the July 1998 Corps Revision which has been previously discussed in this document.

- Woodward-Clyde (April, 1998). Flood Mitigation Alternatives Engineering Analysis for the Muddy River, Boston, Massachusetts, Federal Emergency Management Agency Contract No. EMW-95-C-4678, Task Order No. 186

- Woodward-Clyde (June, 1998). Flood Mitigation Alternatives Benefit/Cost and Environmental Analysis for the Muddy River, Boston, MA.

This report documented the procedures utilized in conducting benefit/cost and environmental assessments of various flood mitigation alternatives and their associated effectiveness. Benefits/Costs were analyzed for selected alternatives using the Federal Emergency Management Agency's (FEMA) computer model entitled "Benefit/Cost Analyses of Hazard Mitigation Projects-Riverine Model", 1.11 (February, 1996).

The model analyzed three mitigation alternatives including: flood proofing residential and commercial structures; replacing the twin culvert system along Park Drive with larger box culverts; and dredging a 30 foot channel in the Lower Fens.

Excluding flood proofing, each alternative modeled would cause induced damages to Emmanuel College. Flood proofing, although requiring consider able amounts of human intervention (i.e. the installation of flood shields at doorways) as well as maintenance and operation conditions, was considered

the most advantageous alternative with a benefit/cost approaching 1 (0.7).

- MEMA (July 10, 1998). Letter from Massachusetts Emergency Management Agency (MEMA) to Federal Emergency Management Agency (FEMA); re: Comments on the June 17, 1998 Woodward-Clyde Flood Mitigation Alternatives report.

The Woodward-Clyde (W-C) report was reviewed by the Massachusetts Department of Environmental Management (DEM) as well as MEMA. The letter addressed a number of issues concerning W-C's baseline condition assumptions and methodologies utilized. The following concerns were noted:

- Incorrect assumption that flood waters would not enter the MBTA GreenLine during a 100-year storm event;
- Incomplete flood risk analysis which did not include analyzing flood risk for the entire Muddy River Watershed;
- Incomplete "benefits" of hazard mitigation analysis which did not comply with OMB Circular Number A-94 (rev. 10/92);
- Incomplete information and analysis of the lower portion of the Muddy River (Charlesgate area) as well as area structural restrictions; considering flood proofing as a "stand alone" alternative solution to the Muddy River watershed flooding problem;
- The possibility of lowering the level of the Charles River and the removal of sediment from the Muddy River Diversion Conduit and the Stony Brook Conduit were not considered in the benefit/cost analysis; and
- Incorrect general benefit/cost and depth-to-damage value estimates for damages, properties, buildings/structures and building contents.

MEMA concluded that the current W-C reports did not provide the comprehensive analysis necessary to provide a fully informed decision on the use of Hazard Mitigation Grant Program (HMGP) funding.

- U.S. ACOE (July,1998). Muddy River Feasibility Study, Boston and Brookline, Massachusetts, Draft Feasibility Report and Environmental Assessment.

- Cortell Associates Inc. (October 29, 1998). Scarboro Pond Investigations.

- Rust Utility Services (November, 1998). Inspection of Stony Brook Culvert.

- Cortell Associates Inc. (November, 1998). Final Black Plastic Demonstration Project: The Riverway and Back Bay Fens: Vegetation Monitoring Report.

Attachment 5

ENF Distribution List

ENF Distribution List

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